SCIENCE ABSTRACTS.

PHYSICS AND ELECTRICAL ENGINEERING.

DECEMBER 1899.

GENERAL PHYSICS.

1834. *Surface Tension of Aqueous Solutions.* **C. Forch.** (Wied. Annalen, 68. 4. pp. 801–816, August, 1899.)—Slight traces of a fatty acid in water produce only a slight diminution of the surface tension at first. If the relation is plotted graphically, ordinates representing surface tensions and abscissæ being $\sqrt[3]{m}$, the curve in its initial portion is parallel to the axis of abscissæ. This changing-point of the curvature approaches lower values of m as the amount of carbon in the acid increases. E. E. F.

1835. *Automatic Mercury Pump.* **R. R. Lawrence.** (Science, 9. pp. 510–511, 1899.)—The novelty about this pump is its electrical control, which is so arranged that sparks made by contact do not foul the mercury. E. E. F.

1836. *Efflux of Gases.* **R. Emden.** (Wied. Annalen, 69. 1. pp. 264–289, September, 1899.)—The author describes the phenomena of periodic condensation observed in the efflux of gases from narrow openings, and photographs them by Dvorak's method of striæ. He shows that stationary sound waves are produced in all gases as soon as the pressure exceeds 1·9 atmospheres. E. E. F.

1837. *Transformation of Iron and Steel.* **H. Le Chatelier.** (Comptes Rendus, 129. pp. 279–282, July 31, 1899.)—The author studies the recalescence and magnetic transformation of iron and steel by means of experiments involving very slow changes of temperature. In steel there is no simple contraction

on cooling; but at the transformation-point there is an expansion of one constituent and a contraction of the other, which, in steel containing 0·9 per cent. of carbon, exactly neutralise each other. In iron the changes of volume are still more complicated. Transformation is gradual, there being no fixed point of transformation as in other simple bodies. The author compares the behaviour of iron with that of selenium, which is stable only between 60° and 214°. Outside these limits only the amorphous variety, vitreous or liquid, is stable. E. E. F.

1838. *Equations of Condition.* **O. Wiedeburg.** (Wied. Annalen, 69. 1. pp. 66–82, September, 1899.)—The author arrives at Gouy's views along an independent line of argument. Gouy considers a system in stable equilibrium, upon which a certain external influence is exerted, consisting of a change of shape or volume, an addition of heat or electric charge, or generally, as the author would express it, in a change of a certain quantity value M of the system. The effects of this influence are of two kinds: either unenduring like changes of temperature, pressure, electric potential, *i.e.*, of a foreign intensity value J'; or enduring, like changes of shape, volume, chemical composition, *i.e.*, of a foreign quantity value M'. Gouy concludes that "unenduring effects are directed against the external influence, while enduring effects favour it." The author puts this in a slightly different form: If the effects $\delta J'$ and $\delta M'$ are regarded as the causes of "reactions" of the system upon the primarily modified value M, it may be said that the reaction δM has a sign opposite to that of the original influence δM if due to unenduring effects $\delta J'$, but the same sign if due to enduring effects $\delta M'$.
E. E. F.

1839. *Recent Research on Chromosphere.* **H. Deslandres.** (Paris Soc. Franc. Phys. Bull. 130. pp. 2–4, 1899.)—A paper similar to that referred to in Abstract No. 899 (1898). C. P. B.

1840. *Gallium in the Sun.* **W. N. Hartley** and **H. Ramage.** (Astro. Phys. Journ. 9. pp. 214–220, 1899.)—The authors, in the course of their examination of minerals, meteorites, &c., have found the element gallium so common a constituent, though always in very small quantity, that they deemed it advisable to determine if there were any traces of it in the sun. Attention was confined to the two best known lines of gallium at λλ 4172 and 4033. Photographs of the spectra of specially prepared pure iron, various gallium compounds, and the solar spectrum were obtained with the large (21 feet) Rowland concave

grating spectroscope of the Royal University of Ireland, and the plates carefully measured. After considering the possible coincidences with adjacent lines due to other elements, the authors conclude that gallium is present in the sun. C. P. B.

1841. *Heat Radiation of the Stars.* **G. E. Hale.** (Astro. Phys. Journ. 9. pp. 360–362, 1899.)—The author commences by reviewing the negative results of C. V. Boys, who used in connection with a 16-inch reflecting telescope a radio-micrometer sensitive enough to show the heat equivalent to that of a candle 1·71 miles away. E. F. Nichols, of Dartmouth College, has spent much time in perfecting the radiometer, and the present form of the instrument is for certain purposes considered superior to either the radio-micrometer, bolometer, or thermopile. In July, 1898, Nichols was invited to test his instrument at the Yerkes Observatory, and the apparatus was installed in the heliostat room, where the stability was so perfect that deflections to tenths of a millimetre could be observed. The radiometer used consisted of a suspension system formed of two mica discs, each 2 mm. in diameter, blackened on one face, and supported by a light cross arm on either side of a thin glass staff, hung by an exceedingly fine quartz fibre in a partial vacuum. Both vanes were exposed to the radiation of the sky at the focus of a silvered glass mirror of 24 inches aperture, fed with light by a siderostat outside. The rays entered the radiometer through a small window made of *fluorite*. With the apparatus so arranged a deflection of 0·1 mm. would be given by a candle fifteen miles distant, neglecting loss by reflection and atmospheric absorption. Seven determinations of the heat radiation of Arcturus gave a mean deflection of 0·60 mm. Vega gave a mean deflection of 0·27 mm. Although the quantitative value of these results is not insisted upon, the author considers that they show the reality of the detection of stellar heat radiation. C. P. B.

1842. *Variations of Apparent Horizon.* **F. A. Forel.** (Comptes Rendus, 129. pp. 272–274, July 31, 1899.)—The author has recently been engaged in the study of aerial refractions and mirages on the surface of Lake Léman, and in the course of his work has been able to make some observations on the displacement of the apparent horizon. The work was carried out at Morges, in a laboratory on the border of the lake, where he could command a length of horizon of about 16 kilometres. Observations were made with a telescope mounted on a stone pier of such height that the horizon was 5 or 6 kilometres distant, and the level was determined by sights, both direct and with an artificial horizon. The angular differences between the *true* and

apparent horizon varied from $+501''$ and $-272''$, showing a total variation of $773''$, or over $13'$ of arc.

The factors causing this difference are: temperatures of the air and water, humidity and agitation of the air, direction and quality of wind, and variations of atmospheric pressure.

Tables are given of the various values observed, from a discussion of which the following general rules are deduced:—

1. The possible error in the position of the true horizon as deduced from observations of the apparent horizon is greater when the air is calm than when it is agitated.

2. It is greater when the air is warmer than the water.

3. Since the observations are more uncertain when the air is calm and warmer than the water, morning observations are better than those made in the afternoon. C. P. B.

1843. *Temperature Variations in the High Atmosphere.* **L. T. de Bort.** (Comptes Rendus, 129. pp. 417–420, August 21, 1899.)—Since April, 1898, more than a hundred unmanned balloons (*ballons-sondes*) have been sent up from Trappes, of which seven exceeded the altitude of 14,000 m., twenty-four of 13,000 m., and fifty-three of 9,000 m. Kites have also been used. In recent months both the old thermometers and the new improved thermometers have been employed, in order to secure comparable results. Thus continuous temperature observations, extending over more than a year, have been obtained for the first time. They show greater variations in the temperature of the higher strata than had been expected. The isothermal of 0° may not be met with below 4,000 m.; the isothermal of $-25°$ has been found at an altitude of 3,000 m. in winter, and at 7,000 and even 8,000 m. in September. The isothermal of $-40°$ is generally near 9,000 m., but it has gone up higher at the end of the summer, and descended to 6,000 m. during winter. A temperature of $-50°$ has never been observed below 8,000 m.; in September, 1898, and July, 1899, it did not occur below 12,000 m. The higher strata of the atmosphere seem to be warmest towards the end of the summer, and coldest towards the end of the winter. But the temperature may change greatly in the course of a few days. Thus the isothermal of $-40°$ was at an altitude of 8,500 m. on March 14th last, and at 6,600 on March 24th. H. B.

LIGHT.

1844. *Astronomical Telescope Objectives.* **H. Harting.** (Zeitschr. Instrumentenk. 19. pp. 104–110, 1899.)—A discussion of methods of calculation based upon first assuming the axial thicknesses of the lenses to be negligible, and then applying the requisite corrections. A numerical example of the calculation is given. A. D.

1845. *Paris Exhibition Siderostat.* **P. Gautier.** (Paris, Soc. Phys. Séances, 1899, 1. pp. 29–50.)—A paper similar to that referred to in Abstracts Nos. 1131 and 1657 (1899). EDITOR.

1846. *Corrections for Chromatic and Spherical Aberration in Astronomical Telescopes.* **R. Steinheil.** (Zeitschr. Instrumentenk. 19. pp. 177–183, June, 1899.)—A comparison of three objectives, comprising that of the Königsberg heliometer, another similar lens, also by Fraunhöfer, and a new lens of Jena glass. The errors introduced by the secondary spectrum tend greatly to exceed those due to spherical aberration. A. D.

1847. *Reversing Prism.* **B. Wanach.** (Zeitschr. Instrumentenk. 19. pp. 161–177, 1899.)—The reversing prism with two refractions and one reflection, used for reversing images without deviating the axis of the rays, is fully discussed, with reference to its applications. A. D.

1848. *Optical Properties of Minerals.* **H. Rosenthal.** (Wied. Annalen, 68. 4. pp. 783–800, August, 1899.)—The author studied the absorption, emission, and reflection of quartz and mica, and compared them with the properties of glass in the region extending from 5,000 to 10,000 $\mu\mu$. In this region the bodies mentioned have characteristic properties which make them specially valuable for testing Kirchhoff's law of radiation. The relation between emission, absorption, and reflection formulated by that law is strictly verified. E. E. F.

1849. *Dispersion of Selenite.* **W. König.** (Wied. Annalen, 69. 1. pp. 1–11, September, 1899.)—The author solves the problem of determining the mean wave-length of a group of rays

by photographing an interference phenomenon whose dependence upon wave-length is known, and determining the wave-length from the distance between the interference fringes. To obtain conditions as uniform as possible the interference fringes of a selenite wedge between crossed and between parallel Nicolls are photographed. The author finds the mean wave-length of curve of sensibility of ordinary Schleussner plates to be 428 $\mu\mu$.
E. E. F.

1850. *Bravais Points.* **P. Lefebvre.** (Comptes Rendus, 128. pp. 930–933, 1899.)—In a centric optical system of foci FF′ and optical constant H a real isosocles triangle can be formed with FF′ as its base and $\sqrt{H}$ for its sides. The summit of this triangle is called by the author the "pole" of the system. If O is this pole, and B and B′ are the Bravais points, OB may be made to coincide with OB′ or its prolongation by making it rotate round the pole O by a certain angle called by the author the "characteristic angle." To construct the image of an object it suffices to turn the radius vector joining the pole to the foot of the object on the axis round the pole through the characteristic angle. The foot of the image then lies on the axis at the end of the radius vector or its prolongation. The image is upright in the first case, and reversed in the second. Its ratio to the object is equal to that of the distances of the pole from the foot of the image and the object respectively, multiplied by the refractive index of the first medium with respect to the second. A centric optical system is completely determined when the axis, a pole, the characteristic angle, and the refractive indices of the extreme media are given. From these data the foci, principal planes, and nodal points can be immediately deduced. E. E. F.

1851. *Kirchhoff's Law.* **A. Cotton.** (Astro. Phys. Journ. 9. pp. 237–268, 1899; also Revue Générale des Sciences, February 15, 1899.)—This is a somewhat lengthy discussion of the position at present held by Kirchhoff's law in the explanation of the various phenomena of emission and absorption of radiant heat and light. C. P. B.

1852. *Blue Steam Jet.* **A. Bock.** (Wied. Annalen, 68. 4. pp. 674–687, August, 1899.)—The blue steam jet described by Helmholtz has a colour of a composition strictly identical with that of the blue of the sky, the intensities of the components being, in accordance with Rayleigh's law, inversely as the fourth power of their wave-lengths. Under conditions of illumination similar to those obtaining in the atmosphere the blue steam jet shows a whitish colour which, when observed at right angles to

the ray, can be made to disappear by turning the analyser. Examination with intense concentrated light shows that the red, yellow, and green rays are polarised, whereas the blue and the violet rays are unpolarised, the result being a phenomenon analogous to Tyndall's "residue blue." The transmitted ray shows reddish-yellow colouration. Regular diffraction does not occur in the blue jet. The jet is invisible when illuminated by red light, but appears distinctly in a blue light, and therefore behaves like a blue body. It is probable that the diameter of the droplets is equal to the wave-length of the blue rays. E. E. F.

1853. *Pressure in Radiometers.* **E. Riecke.** (Wied. Annalen, 69. 1. pp. 119–124, September, 1899.)—The discrepancy between the author's values and those found by Donle is due to an error in the reduction to c.g.s. units and to an imperfect estimation of the moment of inertia of the paddle-wheel. When these errors are corrected values are obtained for the pressure on the radiometer vanes which closely agree with those of Donle. E. E. F.

1854. *Dispersion Model.* **J. H. Vincent.** (Phil. Mag. 46. pp. 557–563, 1898.)—A spiral spring is suspended horizontally by a large number of threads, and is weighted by bullets. To each bullet is attached a weight by another thread. One end of the spring is driven by a metronome, and at a certain frequency there is no transmission of the wave motion. E. E. F.

1855. *Polarisation by Total Reflection.* **R. Geigel.** (Wied. Annalen, 68. 4. pp. 698–704, August, 1899.)—In ordinary cases of total reflection no polarisation of the emergent beam is noticeable. The author has, however, observed such polarisation by means of a hexagonal prism in which a beam is totally reflected a large number of times. Polarisation in the plane of incidence begins to appear after the forty-fourth reflection. The probable explanation is that the component normal to the plane of incidence emerges into the rarer medium and is lost. Light of all visible wave-lengths behaves in the same manner. E. E. F.

1856. *Molecular Rotatory Power.* **H. Pottevin.** (Journ. de Physique, 8. pp. 373–376, July, 1899.)—Pribram has shown that the rotatory powers of aqueous solutions of tartaric acid go on diminishing as we add progressive quantities of methylic, ethylic, or propylic alcohol, or of formic, acetic, or propionic

acid. The author finds that formic and ethylic aldehydes act in the contrary sense, and that the increases in the molecular rotatory power depend not only upon the relative proportions of the aldehyde and the tartaric acid but also upon the proportion of water which is present. Formic aldehyde acts in the same dextrogyric sense upon sugars, upon left-handed amylic alcohol, and upon left-handed essence of matricaria (fever-few): it appears to have no influence upon essence of turpentine. A. D.

1857. *Optical Properties in an Electric Field.* **W. Voigt.** (Wied. Annalen, 69. 1. pp. 297–318, September, 1899.)—The author examines the Hertzian equations with a view of finding whether any electric effects analogous to Zeeman's magneto-optic effect can be predicted from them. When the field is regarded as dependent upon the presence of ponderable matter, and the field components are introduced in their lowest possible power, the formulæ yield the electro-optic phenomena observed by Pockels in acentric crystals, as well as the Kerr effect. For media with sharp absorption lines the formulæ indicate a definite influence of an electric field in the shape of doublings or displacements. Some remarkable converse phenomena also follow, such as the production of a constant electric field in acentric crystals, and a variation of the inductivities of centric crystals and of isotropic bodies by the action of light. E. E. F.

1858. *Intensities of Zeeman Components.* **W. Voigt.** (Wied. Annalen, 69. 1. pp. 290–296, September, 1899.)—The author attempts to find an explanation of the differences in the intensities of the components into which a simple spectrum line is split up in the Zeeman effect. The theory he gives involves an amplification of the Hertzian equations, the resistances opposing the oscillations of the vectors characteristic of each spectrum line being assumed to vary with the strength of field. This assumption also explains the appearance of previously unknown absorption lines when in the magnetic field, and Egoroff and Georgiewsky's observation of the partial polarisation of the light of a monochromatic flame which is viewed at right angles to the lines of force and not subjected to spectrum analysis. E. E. F.

1859. *Kerr Phenomenon.* **H. Abraham** and **J. Lemoine.** (Comptes Rendus, 129. pp. 206–208, July 24, 1899.)—Experiments on the gradual but rapid decay of the birefringence when the field is abolished. Disruptive discharges are used, and the light from the spark itself is examined through the Nicol. When the

spark is set at different distances the light has to traverse different lengths of path before it passes between the condenser plates where it is acted upon in the electric field. When the source of light is at a greater distance, more time has been allowed to enable the Kerr-phenomenon-producing condition to die away, and it is found that the electro-optic phenomenon is reduced to one-half in one 400,000,000th part of a second. A. D.

1860. *Spectra of Oscillating Discharges.* **G. A. Hemsalech.** (Comptes Rendus, 129. pp. 285–288, July 31, 1899.)—The author studies in detail the influence exerted by a self-induction in the discharge circuit upon the spectrum of an oscillating spark discharge. The first effect of the introduction of the self-induction is to lower the temperature, and thus eliminate the lines due to the surrounding gas from the spectrum of the spark. A table of the lines displayed by bismuth is given for three different values of the self-induction. In hydrogen under atmospheric pressure the lines due to the oscillating discharge are sharp, and this sharpness is not interfered with by the sparking distance. By employing 0·0038 henry the author has obtained lines which ordinarily only appear in Geissler tubes. E. E. F.

1861. *Red End of Argon Spectrum.* **C. Runge.** (Astro. Phys. Journ. 9. pp. 281–283, 1899.)—The author has recently been furnished with photographic plates specially sensitised for the region λ 7500, in the extreme red, and has obtained photographs of the argon spectrum with a concave Rowland grating of 1 metre radius, extending from λ 7207 to λ 8015. A table of the lines and relative intensities is given. C. P. B.

1862. *Structure of Hydrogen Lines in Solar Spectrum.* **L. E. Jewell.** (Astro. Phys. Journ. 9. pp. 211–213, 1899.)—The wave-length of Hδ, the blue line of hydrogen, has been given a certain value by Rowland in his table of standard wave-lengths, but this has been thought to be about one-tenth of an Ångström unit in error by some spectroscopists. The author of the present paper, who is responsible for the measurements from which Rowland's table is compiled, has remeasured the plates, and, finding no error in evidence, explains the discrepancy by the fact that the structure of the solar spectrum at this point has some effect on the position of maximum intensity which is chosen for the centre of the line. The measurements of hydrogen lines obtained during a solar eclipse or from a vacuum tube are not complicated by the presence of neighbouring lines, and thus a slight difference in *estimated* wave-length is possible. C. P. B.

1863. *Efficiency of Spectroscopes.* **H. C. Lord.** (Astro. Phys. Journ. 9. pp. 191–202, 1899.)—The difficulty involved in the mathematical analysis of the various combinations of optical systems for a spectroscopic train is in many instances complicated by the resulting integrals being indeterminate (directly). To lessen this the author has developed a graphic method whereby the curves corresponding to the integrals may be constructed by use of the planimeter, and consequently the comparison of various systems made with greater ease. The cases he discusses are: (1) a *bright* slit of angular width σ on a *dark* background; (2) a *dark* line of angular width σ on a *bright* background; (3) a slit of angular width σ illuminated by light of all except certain stated wave-lengths, viewed through a dispersive train (*e.g.*, the solar spectrum). The curves obtained are illustrated by actual examples calculated for well-known spectroscopes, and they show by inspection the relations existing between the slit width, aperture and focal length of lenses, and grain of photographic plate; so that, if one or more are varied, the effect on the performance of the instrument can be predicted to a certain extent. C. P. B.

1864. *Concave Grating Stellar Spectroscope.* **S. A. Mitchell.** (Astro. Phys. Journ. 10. pp. 29–39, June, 1899.)—A short account has previously been given of the promise of Rowland's concave gratings in the photography of stellar spectra (Astro. Phys. Journ. 8. p. 157, March, 1898), and the present paper gives the results obtained with apparatus specially designed for the purpose. The usual method of working with the concave grating is to mount slit, grating, and camera on the circle having its radius equal to half the radius of curvature, but this would necessitate the employment of a subsidiary telescope to project an image on the slit. In the direct method adopted the slit is dispensed with, and the light from the star, after diffraction and reflection from the grating surface, is brought to focus on a curve situated about half the radius of curvature from the grating. The spectrum for a short distance on either side of the axis is practically normal. The grating used has a radius of curvature of *one* metre, and is ruled with 7,219 lines to the inch, the ruled surface having an area $2 \times 5\frac{3}{4}$ inches. This was mounted on the $9\frac{1}{2}$-inch Hastings refractor, and although this is on the sixth floor of a building in Baltimore, excellent results have been obtained. Later the grating was used at the Yerkes Observatory. The lines are adjusted parallel to the equator, so that errors of the driving clock will not spoil the definition of the spectrum lines. As the light passes through neither object-glass nor prisms, there is little absorption of the ultra-violet region. The photographs in the *first* order were $1\frac{1}{4}$ inches long from Hβ (λ 4861) to the extreme ultra-violet, and usually both first and second orders were obtained on one plate. The hydrogen series in such stars as Sirius is specially

well shown, twenty-one lines being identified on one plate. Of special interest are the results of two plates obtained of the spectrum of the Orion nebula with exposures of about $3\frac{1}{2}$ hours, the wave-lengths of twenty-nine lines being given in the article. A method of using the grating so as to give absolute wave-lengths for work on motion in the line of sight is also given, and a *résumé* of the advantages of using concave gratings. C. P. B

1865. *Spectroscope of Fixed Deviation.* **P. Pellin** and **A. Broca.** (Paris, Soc. Phys. Séances, 1899, 1. pp. 24–29.)—A paper similar to that referred to in Abstract No. 1480 (1899).
EDITOR.

1866. *Becquerel Rays.* **J. Elster** and **H. Geitel.** (Wied. Annalen, 69. 1. pp. 83–90, September, 1899.)—The authors have made another attempt to discover the origin of Becquerel rays, but again without success. Thinking that the radiation might be influenced by the impact of kathode rays, they exposed a piece of pitch blende from Joachimsthal to kathode radiation, and determined whether that produced any difference in the Becquerel rays. It did not. Nor could any influence of temperature be demonstrated. The authors believe the Becquerel rays to be Röntgen rays of small intensity, and they render this very probable by two further analogies which they have discovered. A magnetic field not only increases the resistance of a partial vacuum, but it also retards the discharge of an electrified body provoked by the impact of either Röntgen rays or Becquerel rays. An obvious explanation would be that the Becquerel rays are deflected by a magnet; but when the rays were made to produce a bright patch on a fluorescent screen no magnetic field could displace that patch. E. E. F.

1867. *Becquerel Rays.* **O. Behrendsen.** (Wied. Annalen, 69. 1. pp. 220–235, September, 1899.)—The author brings some further evidence in support of the identity of Röntgen and Becquerel rays. He found that the latter are capable of exciting fluorescence in a plate of fluorspar. He also definitely disproved the polarisation of Becquerel rays, which their discoverer had relied upon as a distinction from Röntgen rays. He obtained a highly active substance by sublimating powdered pitch blende. He calls this substance X-sublimate, and finds the radio-activities of uranium, pitch blende, and X-sublimate to be in the ratio of 1 to 8·47 to 52·24. Pitch blende shows a strong variation with temperature, in spite of Elster and Geitel's negative results. Cooling to $-50°$ produces a reduction of the activity. Heating to 100° increases the activity, but incandescence destroys it.

X-sublimate shows the same behaviour, and so does uranium, except that the increase on gentle heating is not so evident. The author believes that he succeeded in eliminating all sources of error, such as that due to convection. He does not believe in a complex atom, but favours the theory of unstable molecules.

E. E. F.

1868. *Radio-active Baryta and Polonium.* **F. Giesel.** (Wied. Annalen, 69. 1. pp. 91–94, September, 1899.)—The author has examined a large number of radio-active barium salts from de Haën's chemical factory. When crystallised fresh from the aqueous solution, they gradually increase in activity. After some days or weeks they reach a maximum, and after that the activity remains constant as long as the crystals are kept free from moisture. Even concentrated solutions of the salts have some activity, but that gradually disappears. The crystals first crystallised are the most active. The author has not succeeded in isolating the active element, whether radium or polonium. But by precipitation with sulphuretted hydrogen he has obtained a substance which exceeds the best barium salts in activity. The rays ascribed to polonium are more easily absorbed by metals than those ascribed to radium, and the former rays therefore yield better radiographs of the hand, &c., as they show more contrast. The author does not think that fractional crystallisation alone will yield more highly active substances.

E. E. F.

1869. *Polarised Fluorescence.* **G. C. Schmidt.** (Wied. Annalen, 68. 4. pp. 779–782, August, 1889.)—That uranium salts and certain solid solutions of aniline dyes in phthalic acid do not emit polarised fluorescence has been confirmed by the author by means of a new fluoroscope, in which the parallel beam from an arc lamp was changed into a convergent beam by a quartz lens, and was then allowed to enter the crystal under examination. A violet glass was placed in front of the lens. It transmitted the whole of the blue and violet, and a little of the red. The path of the beam through the crystal was observed from the side by means of a Nicol or a dichroiscope. Among the crystals thus investigated were the uranyl compounds of sodium and potassium acetates, and of ammonium nitrate. None of these showed any polarisation in their fluorescent light. Glass under pressure, which shows double refraction, failed to show polarised fluorescence. Uranium glass gave equally negative results, and so did carbon bisulphide containing a little chlorophyll, which shows a brilliant red fluorescence. Sohncke's rule, according to which the fluorescence of all bi-refracting crystals is polarised, has therefore several pronounced exceptions.

E. E. F.

1870. *Diffraction of Röntgen Rays.* **M. Maier.** (Wied. Annalen, 68. 4. pp. 903–916, August, 1899.)—This is a series of experiments made to determine the "wave-length" of Röntgen rays by means of diffraction. In the absence of regular reflection and of polarisation, the diffraction method is the only one available, and that method has not yielded anything like consistent results except in the hands of Fomm. The latter used a linear source of Röntgen rays, a slit parallel to it, and a screen behind the slit, on which he detected two systems of fringes, one on each side of the image of the slit, and one system in the image itself. The author, in endeavouring to repeat this experiment, used every variety of focus tube and altered the elements of the arrangement in every conceivable manner, but without success. It was only when he had recourse to ordinary Crookes or Hittorf tubes that he obtained the fringes sought, or rather the first minimum within the image. The distance between the line of light and the slit was 200 mm., between the slit and the screen 180 mm., and the width of the slit was 0·1 mm. The resulting wave-length was 15 $\mu\mu$ consistently with two tubes. That would be about $\frac{1}{30}$ of the wave-length of ordinary light, and that value agrees well with that obtained by Fomm, though it remains to be proved that we are dealing with true diffraction. E. E. F.

1871. *Diffraction of Röntgen Rays.* **H. Haga** and **C. H. Wind.** (Wied. Annalen, 68. 4. pp. 884–895, August, 1899.)—The "interference fringes" produced by Röntgen rays in Fomm's experiment, and used by him for determining the wave-length of Röngten rays, are, according to the authors, nothing but a hitherto unknown optical illusion. That they are not diffraction fringes is shown by an experiment with a tapering slit, which produces two fringes representing Fomm's "first minimum." The fringes run alongside the two edges of the image of the slit, but always keep parallel to them, instead of diverging from them in the narrower portions. They eventually cross. The illusion is produced along the edges of penumbra. The edge of the geometrical image appears brighter where the penumbra begins, and of course darker on the negative. Hence the dark fringe. This reasoning does not, of course, explain away Fomm's system of fringes, but they are doubtful in any case. The authors do not reject the possibility of Röntgen rays producing diffraction phenomena, and they describe, in fact, a curious periodic broadening of a tapering slit image, which would indicate a spectrum consisting of several bands in the very extreme ultra-violet. But the wave-length guessed at is only of the order of 0·1 $\mu\mu$. E. E. F.

HEAT.

1872. *Thermometric Corrections.* **F. Grützmacher.** (Wied. Annalen, 68. 4. pp. 769–775, August, 1899.)—The author describes the process of thermometer testing adopted at the Reichsanstalt. All temperatures between 0° and 100° are now reduced to the international hydrogen scale. At higher temperatures the air thermometer is retained as a standard, since comparisons between that and the hydrogen thermometer are not completed yet. Within the limits mentioned the discrepancy between the two gas thermometers does not exceed 0·011°.

E. E. F.

1873. *Air Thermometer.* **L. Holborn** and **A. Day.** (Wied. Annalen, 68. 4. pp. 817–852, August, 1899.)—In the construction of gas thermometers for use at high temperatures, either porcelain or platino-iridium may be used as a material of the vessel. The authors decide on the whole in favour of the platinum alloy. Hydrogen passes freely through incandescent platinum, but nitrogen does not, and the nitrogen pyrometer is reliable up to 1,300°. The porcelain cylinder suffers under various drawbacks. It is not gaslight unless it is glazed, and the glaze begins to melt at 1,100°. At 1,450° the porcelain itself softens, and the vessel is filled with vapour given off by the glaze. The authors use a saltpetre bath for producing temperatures up to 750°, and a zinc bath up to 900°. Beyond that they heat by means of an electric current, since at the highest temperatures flame gases pass through the walls of the vessel. They determined the coefficient of expansion of the platinum alloy used with great accuracy.

E. E. F.

1874. *Measurement of Temperature and Pressure.* **K. Scheel.** (Zeitschr. Instrumentenk. Beib. 9. pp. 69–72, 10. pp. 81–84, 11. pp. 89–92, 12. pp. 101–104, 13. pp. 109–111, 1899.)—This paper is a short history of the methods used for measuring temperatures and pressures, and especially of the latest developments. To render the mercury thermometer an exact instrument, at the suggestion of the *Bureau International*, a large stock of a certain quality of glass (*verre dur*) was obtained by Tonnelot, of Paris, and out of it a number of thermometers have been constructed. These, when systematically studied as to calibration and change of zero point, are found to give readings in accordance to two or three thousandths of a degree. The scale of temperature thus arbitrarily defined was compared with that of the hydrogen thermometer. In Germany the same object was attained in a more complete manner by determining the chemical composition and mode of manufacture of certain

glasses suitable for thermometer-making; these are Schott & Co.'s "Normal thermometer glass," 16^{III} and a borosilicate glass 59^{III}, both of which show very small depressions of the freezing-point; the latter only 0·05° for the interval 0° to 100°. The latter glass is now almost exclusively used for thermometer-making, and some 370,000 thermometers have so far been tested in the German testing laboratories. Glass 59^{III} has such a high melting-point that it can be used for making thermometers to read up to 550°, the glass showing no signs of softening at that temperature. In order to prevent the mercury from boiling, the tube above the mercury is filled with carbon dioxide under high pressure, taken direct from a bottle of liquid carbon dioxide; the tube is then temporarily shut off by melting a little plug of shellac into the capillary, and under protection of this is fused off.

For low temperatures toluene has been found the most appropriate liquid to use; its scale has been compared with that of the gas thermometer. Lately Kohlrausch has adopted petroleum ether for the same purpose, as it remains liquid down to −200°, although somewhat viscous. For still higher and lower temperatures, either a platinum resistance thermometer or a thermo-couple is employed. The latter, which seems to be preferred in Germany, is made of Pt and Pt with 10 per cent. Rh (Le Châtelier's combination), the wires being about 0·6 mm. thick and 1·5 m. long, welded together at the ends, and enclosed in a porcelain tube for protection from furnace gases. The thermo-couple is available up to 1,600°; it has been compared with the gas scale, and temperatures up to 1,000° may (it is claimed) be measured to within 5°.

A description follows of certain mercury manometers, including those of Cailletet and Amagat for high pressures, and a less known form, the "broken" manometer, for attaining high pressure without the use of a great vertical height. Such an instrument has lately been adopted by the Reichsanstalt, and consists of twenty glass tubes, each two metres long, mounted side by side, and connected alternately at the top and bottom; the lower half of each tube is filled with mercury, the upper half with water, so that when pressure is applied to one end the mercury rises in all the even tubes and falls in all the odd ones. The twenty menisci are read by a mirror scale, and give the measure of the pressure. The glass tubes will stand 200 atmos. pressure; the maximum error is given as 0·02 atmos.

For high pressures the Reichsanstalt has adopted a piston manometer essentially similar to that of Amagat, the pressure being balanced by weights on a piston of measured diameter. This at 20 atmos. gave a reading 1/500 different to that of the mercury manometer. R. A. L.

1875. *Calorimetry.* **S. Lussana.** (Rivista Scientifica, 30. pp. 176–183, 1898.)—A calorimetric apparatus is described which is on the lines of that used by Fabre and Silbermann, but is so arranged that the calorimeter may be brought to and maintained at a temperature higher than the external temperature, while the substance to be studied may be maintained at a temperature equal to the external. A. D.

1876. *Conditions of Sensitiveness of the Thermopile and Bolometer.* **H. C. Pocklington.** (Cambridge Phil. Soc. Proc. 10. pp. 66–71, June 7, 1899.)—In the bismuth-antimony thermopile the bars should be 2 metres long and their cross-sections should be as 2·56 to 1; with the ordinary length of 2 cm. and this ratio of cross-sections the sensitiveness is greatest, and about one-fifth of the theoretical maximum, if the resistances of the thermopile and galvanometer are as 1 to 1·091. With the bolometer the galvanometer should have the same resistance as the strip, and the arms which are attached to the contacts of the strip with the galvanometer and battery should be respectively as large and as small as possible. If one of these arms is made with resistance equal to that of the strip, as is usually the case for practical reasons, the resistance of the galvanometer must be half or twice that of the strip, as the case may be, and the sensitiveness is less than the maximum by about 29 per cent. R. E. B.

1877. *Pressure, Volume, and Temperature in Fluids.* **E. H. Amagat.** (Journ. de Physique, 8. pp. 353–362, July, 1899.)—In the expression $(p+\mathrm{P})\,(v-a)=\mathrm{RT}$, if we use, instead of P (the internal pressure), the quantity $\pi=\mathrm{W}/3v=\Sigma r\phi(r)/3v$, where W is the virial of the interior forces, we obtain the simplified expression—

$$\left(p+\frac{\Sigma r\phi(r)}{3v}\right)v=\mathrm{RT},$$

in which the co-volume a disappears. Attention might then be confined to this term π; and discussion of the experimental results leads to the expression given in Abstract No. 1007 (1899). Applications to saturation conditions are discussed. R is slightly higher than $273^{-1}=0{\cdot}003663$; because at zero, when $p=1$ and $v=1$, the expression becomes $1+\pi=\mathrm{R}\times 273$ and π can only become $=0$, so as to make the expression $\mathrm{R}\times 273=1$, by referring to the mass of the gas at a vanishingly low pressure. But this is the aim that should be kept in view, so as to maintain the consistency of the thermodynamic equations; and if the zero isothermal is prolonged to the axis of pv, and if with the unit mass of gas as above defined it gives $(1+\varepsilon)$ as the value of the ordinate p_0v_0 instead of 1, then the true unit mass referred to should be that unit divided by $(1+\varepsilon)$. A. D.

1878. *Rectilinear Diameters and the Laws of Corresponding States.* **E. Mathias.** (Journ. de Physique, 8. pp. 407–413. August, 1899.)—If a fluid has a rectilinear diameter, its densities δ and δ' in the saturated states of liquid and vapour at any absolute temperature T are connected by a relation of the form—

$$\tfrac{1}{2}(\delta+\delta')=A-BT,$$

where B is the tangent of the slope of the diameter and A is another constant for the substance, given by $A=\Delta+B\Theta$, Δ and Θ being the critical density and absolute temperature. Thence follows at once—

$$B\Theta/\Delta=\{(\delta+\delta')/2\Delta-1\}/(1-T/\Theta)\equiv a,$$

and if the substance belongs to a group which conform to the laws of corresponding states this quantity a must be constant for the group. Now a is shown by observation to vary from 0·68 for nitrogen to 1·09 for ethyl propionate and not to have the same value even for the different members of a homologous series: hence the laws of corresponding states do not rigorously apply to rectilinear diameters except possibly in the neighbourhood of the critical states.

Amagat's procedure is unsatisfactory; for though it leads to a correct value of the critical density of ethylene, it gives one for ether which is 40 per cent. in defect of that deduced from experiment. R. E. B.

1879. *Specific Heat of Water.* **H. L. Callendar** and **H. T. Barnes.** (Electrician, 43. pp. 775–778, September 22, 1899. Paper read before the British Association, 1899.)—A current of water flowing through a fine tube is heated by an electric current through a platinum conductor in the axis of the tube, convective and radiative losses of heat being diminished by a vacuum jacket, with its external surface kept at the temperature of the inflowing water. When the steady state has become established the mass of water M that passes through the tube in a given time t is determined, and also the resulting rise of temperature $\delta\theta$ (by means of a differential platinum thermometer reading to 0·001° C.), the current through the conductor C, and the difference of potential E of its ends. H being the very small external loss of heat, the specific heat (in mechanical units) of water at its mean temperature in the tube J is given by—

$$JM\delta\theta=EC\delta t-H.$$

The experiments extended from 0° to 60° C., $\delta\theta$ being generally from 8 to 10° and M about 500 grammes, and, on the assumption that at 15° C. the E.M.F. of the Clark cell is 1·4342 volts, the resulting

formula (in joules per gramme per C. degree) for this range of temperature was—

$$J = 4{\cdot}181\{0{\cdot}9982 + 0{\cdot}0000045\ (\theta - 40)^2\}$$
$$= 4{\cdot}174 + 0{\cdot}00001881\ (\theta - 40)^2,$$

showing the minimum value to occur at 40° C. and the increase in J to be very rapid on approach to 0° C.

An interesting discussion of the results of other experimenters is given, and also reasons for provisionally taking for the range from 60° to 220° C. the formula—

$$J = 4{\cdot}181\ (0{\cdot}9944 + 0{\cdot}00004\ \theta + 0{\cdot}0000009\ \theta^2),$$

which represents Regnault's values diminished by a constant quantity. R. E. B.

1880. *Dilatation of Porcelain.* **T. G. Bedford.** (Electrician, 43. p. 780, September 22, 1899. Abstract of Paper read before the British Association, 1899.)—The linear expansion of Bayeux porcelain with rise of temperature is found to be represented fairly well by the formula—

$$l/l_0 = 1 + 0{\cdot}000003425t + 0{\cdot}000000001107t^2$$

between 0° and 600° C., and the results found for higher temperatures up to 830° C. do not depart far on either side from this curve. Reading microscopes were used to determine lengths, and temperatures were measured by the resistance of a platinum wire. R. E. B.

1881. *Dilatation of Iron and Steel at High Temperatures.* **H. Le Chatelier.** (Comptes Rendus, 129. pp. 331–333, August 7, 1899.)—The expansions were determined from the tilting of a cast-silica mirror owing to the unequal expansion of its two supports, one of Sèvres porcelain and the other of the body studied. Three periods are to be distinguished, viz., the range of temperatures in which molecular transformations occur and the temperatures respectively lower and higher than this range.

Cast iron containing 0·057 per cent. of carbon and six steels containing percentages of carbon ranging from 0·205 to 1·21 were examined. I. At *low* temperatures their coefficients of expansion are sensibly identical, being about 0·000011 at ordinary temperatures and increasing regularly to 758°, where their value is about 0·000017. II. At *high* temperatures the expansion-coefficients

increase rapidly with the percentage of carbon, being 0·000015, 0·000017, 0·000022, 0·000029 for the percentages 0·057, 0·205, 0·84, 1·21. III. For the range of transformation the observations were not satisfactory; but for the percentages of carbon 0·057, 0·205, 0·49, 0·84, 1·21, for which the mean temperatures of transformation were 840°, 768°, 728°, 730°, 725°, the contractions observed were 0·0026, 0·0023, 0·0021, 0·0008, 0·0010. A great number of the anomalies observed are explicable on the assumption that there occur, with more or less relative retardation, (i.) a molecular transformation of the iron, accompanied by a contraction of 0·0026, (ii.) the solution in this transformed metal of the iron carbide Fe_3C, accompanied by an expansion which would also be 0·0026 for a 0·09 percentage of carbon. R. E. B.

1882. *Kinetic Theory of Liquids.* **W. Voigt.** (Wied. Annalen, 69. 1. pp. 324–326, September, 1899.)—This is a reply to Jäger's criticism (see 1899, Abstract No. 1694) of the author's work. The author points out that he does not adopt rigid spheres as his atomic units, but "impact spheres" (*Stosskugeln*) defined as spheres constructed about molecules such that the centre of gravity of another molecule cannot penetrate into the sphere without experiencing a deflection. E. E. F.

SOUND.

1883. *Theory of Wind Instruments.* **F. Larroque.** (Comptes Rendus, 129. pp. 95–98, July 10, 1899.)—The tubes of brass instruments consist of a conical part with its vertex at the mouth of the player, and an enlarged portion at the further end. The effect of the enlarged end is to emphasise the higher harmonics. For the pitch of the note emitted is not altered if the cone is continued in its regular shape to the end of the tube. The portions situated between the cone and the brass resound to the notes produced in the tubes, and strengthen them while increasing the expenditure of wind. An increased expenditure of power implies an increased prominence of the overtones. E. E. F.

1884. *Beats of Strings.* **C. Maltézos.** (Comptes Rendus, 129. pp. 438–439, August 28, 1899.)—A mathematical theory of the vibration of strings indicates that the number of beats is proportional to the square root of the section, inversely proportional to the cube of the length, and inversely proportional to the root of the tension. Experiment shows, however, that the law of length does not hold good, the number of beats heard being nearly inversely proportional to the length. The author therefore concludes that his theory is not complete, and that the beats in a single string are probably due to a difference of elasticity in two directions across the sectional area. E. E. F.

1885. *High Pitches.* **F. A. Schulze.** (Wied. Annalen, 68. 4. pp. 869–883, August, 1899.)—The mathematical theory of Quincke's interference method of measuring high pitches is developed and its practice described. The author converts it into an objective method by closing the mouth of the tube with a cork carrying a small plate of mica on which sand is strewn. When the tones traversing the two branches of the Quincke tube coalesce to a maximum the grains of sand are projected upwards some 5 mm. The author verifies Stumpf and Meyer's criticism of Appunn's small tuning-forks. E. E. F.

ELECTRICITY.

1886. *Ribbon and Dark Lightning.* (Nature, 60. pp. 423–424, August 31, 1899.)—This article is illustrated by a reproduction of a photograph of lightning taken at Devonport (Tasmania) which shows a broad or ribbon-like flash with several dark ramified flashes. It is suggested that to obtain information as to the reason of the ribbon appearance systematic attempts should be made to photograph lightning with cameras having a known rate of movement, and an arrangement for determining the angular diameter of the ribbon. The dark flashes spreading from the main bright one are attributed to photographic reversal of previous bright flashes. Photography is thus held to give no support to the view that dark lightning has a real physical existence, and the letters from Lord Kelvin (August 10th) and W. J. Lockyer (August 24th) show that, when visually observed, dark lightning is an effect due to fatigue of the retina. E. H. B.

1887. *Electric Charge of Electrolytic Gas.* **W. Kösters.** (Wied. Annalen, 69. 1. pp. 12–33, September, 1899.)—The author attempts to determine the causes of the electrification of gases evolved by electrolysis. For this purpose he passed several such gases in the nascent state through liquids, and studied the power thus acquired of producing an electrometer deflection. Both hydrogen and oxygen were positively electrified by passing through sulphuric acid, just as they are when given off by the electrolysis of that acid. But oxygen from an oxygen tube, passed through a solution of caustic potash, showed positive electrification, whereas electrolysis of the same solution yields negatively electrified oxygen. The author considers that this points to the identity of the electrification observed on blowing through with what Lenard calls "waterfall electricity." Another peculiar phenomenon, first observed by Townsend, is that hydrogen, developed by electrolysis of dilute hydrochloric acid with platinum electrodes, is positively electrified, whereas its charge becomes negative after a while when carbon electrodes are used. E. E. F.

1888. *Loss of Electric Charge by Evaporation.* **H. Pellat.** (Paris, Soc. Phys. Séances, 1899, 1. pp. 14–24.)—A paper similar to those referred to in Abstracts Nos. 562 and 1375 (1899). EDITOR.

1889. *Disruptive Discharge.* **W. de Nikolaieve.** (Journ. de Physique, 8. pp. 432–433, August, 1899.)—To determine the precise effect of a disruptive discharge upon the intervening air, the author places a layer of cotton-wool, pressed between two ebonite rings, in the path of the spark. After the spark has passed, it is found that the cotton-wool is traversed by a canal about 6 mm. wide, with sides consisting of compressed cotton-wool. Soaking the cotton-wool in water or in vaseline oil enlarges the canal, but produces no essential difference in its structure. Sheets of aluminium or copper introduced in the path of the spark show depressions, which on microscopic examination are found to contain congealed droplets of the metal. E. E. F.

1890. *Genesis of the Electric Spark.* **B. Walter.** (Wied. Annalen, 68. 4. pp. 776–778, August, 1899.)—The author has collected some further evidence to show that every spark discharge is preceded by several tentative brush discharges which proceed from both electrodes. The positive brush is four or five times the length of the negative brush, and is much branched. There is a thickening in the central portion of the spark not covered by previous brushes, evidently due to an accumulation of energy in the central region. Even the final spark is not homogeneous, as is seen by a faint bridge which sometimes crosses a curved portion. E. E. F.

1891. *Pressure within the Spark.* **E. Haschek** and **H. Mache.** (Wied. Annalen, 68. 4. pp. 740–751, August, 1899.)—That the sudden increase of pressure produced by a spark is not due to its heat is proved by its subsidence immediately on the cessation of the spark, and by its magnitude, which may amount to 16 mm. in a pressure of 56 mm. The authors have arrived at what they believe to be a close estimate of the pressure within the spark itself. Having obtained an idea of the actual dimensions of the spark by photography, they measured the increase of pressure per unit surface of the vacuum tube by a specially constructed manometer. By reducing the total increase of pressure to the surface of the spark the pressure within the latter was obtained. In the case quoted it was 11·3 atmospheres. It was found to increase with the energy, the pressure of the gas, and the sparking distance. The authors point out a similar increase of pressure when an arc light is established. They believe the pressure to be intermittent, and estimate it at 2 to 3 atmospheres. They attribute the pressure in both cases to particles projected from the electrodes. It is higher in sparks between carbon electrodes than between electrodes of iron, zinc, or other metals.

E. E. F.

1892. *Work Consumed in a Spark-Gap.* **E. Riecke.** (Wied. Annalen, 68. 4. pp. 729–739, August, 1899.)—In the course of some work with a 40-plate Toepler machine, originally designed for experiments on vacuum discharges, the author had occasion to determine the work expended in spark-gaps of different lengths. The influence machine was driven by a motor provided with a speed indicator. The voltage, current strength, and speed were taken with and without the spark-gaps. With a constant speed of 13 turns per second the watts per turn were found to be, for various lengths of gap—

Gap 2 cm.	1·64 watts	.....	Heat	4·96	grm.-cal.	per sec.
„ 4 cm.	2·08	„	„	6·05	„	„
„ 6 cm.	3·27	„	„	9·56	„	„
„ 8 cm.	1·79	„	„	5·39	„	„

An interesting result brought out by the above table is that the work diminishes as the spark-gap is widened from 6 cm. to 8 cm. Since the difference of potential increases at the same time, it follows that the quantity of electricity discharged is a good deal less, and that is obvious from the appearance of the sparks. The author endeavoured to confirm the above results by substituting tubes filled with cadmium iodide solution for the spark-gaps. The results were then somewhat higher. E. E. F.

1893. *Conduction in Rarefied Gases.* **E. Bouty.** (Comptes Rendus, 129. pp. 152–155, July 17, and pp. 204–206, July 24, 1899.)—An isolated conductor (a flask) introduced between the armatures of a condenser actuated by a potential difference V, produces an increase in the capacity of the system, which is the same whether the flask be filled with a metallic substance (mercury) or an electrolyte, or whether its conductivity be due to a superficial film of moisture, inside or outside, and which is independent of the value of V. But a dry flask full of air produces only a trifling increase of capacity if the air be at the ordinary pressure: a non-conductor therefore acts differently from a conductor. Vacuum tubes act in this respect like air at ordinary pressure: the extremely rarefied air is a non-conductor, whatever the voltage. Geissler tubes (1 to 5 mm.) at moderate voltages act in the same way, but at high voltages their contents come to act as conductors (with a flash of light), and at certain intermediate critical voltages the tubes may act in one way or the other, according to surrounding circumstances not yet fully ascertained. These observations tend to tell against the idea of there being free ions or any electrolytic conduction at voltages short of those under which the electric elasticity of the gas breaks down. The relation between the electromotive force and the gaseous pressure is further examined in pp. 204–206. The general result is that the values of the electromotive force f corre-

sponding to given values of the pressure p are, with tubes of different forms and condenser plates at different distances, proportional to one another; that within the limits tried $f = A(1 + Bp + Cp^{-1})$; that the term in p^{-1} preponderates at very low pressures, as if the molecules only tended to weaken the ether at their own locations; that when they are near to one another their mutual action increases the cohesion proportionately to their number; that B appears to be independent of the nature of the gas; that C appears, with less certainty, to be the same; that A increases somewhat with the molecular weight (1·00 for H, 1·55 for CO_2); and that if we measure p in millimetres of mercury, $B/C = 4·4$. A. D.

1894. *Gaseous Conduction in Incandescent Lamps.* **J. Stark.** (Wied. Annalen, 68. 4. pp. 919–948, August, 1899.)—The fact that flame gases have considerable electric conductivity leads to the inference that the hot gases in the bulb of an incandescent lamp may be partly instrumental in conveying the current through the lamp. This is made very probable by the author's observation that the current can be tapped by inserting metallic electrodes in the bulb, which are not in contact with each other nor with the filament. The current through the gas is subject to deflection by a magnet. There is a well-marked difference in the behaviour of a glowing carbon filament when charged positively and when charged negatively. A negative charge is dissipated more easily than a positive one. This explains the difference in the attraction exerted by differently charged bodies upon the glowing filament. It also explains the unidirectional character of the tapped current through the inserted electrodes. The temperature of the filament is about 1,500° C. At that temperature the gas still acts more as a dielectric than as a conductor; but at 2,000° C. all gases are probably conductors, and then we have practically an arc lamp. E. E. F.

1895. *Conductivity of Gases exposed to Discharge Rays.* **J. J. Thomson.** (Cambridge Phil. Soc. Proc. 10. pp. 74–77, June 7, 1899.)—The properties of discharge-rays, or "Entladungs strahlen," were discovered and described by E. Wiedemann and Hoffmann (see Physical Society's Abstracts, 1897, No. 208). They emanate from a region through which an electric discharge is passing; they move in straight lines, are not deflected by a magnet, and are stopped by solids, liquids, and some gases, such as carbon dioxide. Their effect upon the electric conductivity of gases exposed to them is studied in the present series of experiments. The discharge is produced between two electrodes, which can be moved along the axis of a tube, keeping the distance between them constant. From the side of this tube an opening, closed by wire gauze, leads to another tube at right angles to the first,

and has itself a lateral tube near its centre. Two aluminium cylinders with insulated wires along their axes are placed in these tubes in such a manner that one can be reached by a rectilinear path from the electrodes, while the other cannot be so reached. The author studies the rate of leakage of electricity between each cylinder and its axial wire for various pressures of contained air, and for exposure to different parts of the discharge. He finds that the Entladungs strahlen produce conductivity of the gases through which they pass, and that the effect is greater in hydrogen, and less in carbon dioxide, than in air. The radiation is emitted more copiously from the neighbourhood of the electrodes than from the rest of the spark : it appears therefore to be connected with the ionisation of the gas and its recombination. These phenomena are compared with the production of secondary rays when a gas is exposed to Röntgen radiation in which ionisation is taking place, and when Röntgen rays fall on a metallic surface ; they are probably due to pulses arising from the sudden stoppage of the electrified ion. By bringing the gas experimented upon very near to the arc, and taking special precautions to prevent convection from the arc to the gas, the effect can be observed in air at ordinary pressure. J. L. H.

1896. *Motion of a Charged Ion in a Magnetic Field.* **J. J. Thomson.** (Cambridge Phil. Soc. Proc. 10. pp. 49–52, June 7, 1899.)—This treats of the motion of an electrically charged particle in a magnetic field, when the free path of the particle is so short that the effects of collisions form a dominant factor. The problem in hand is therefore complementary to the case of the kathode rays, in which the free path is so long that the effects of collisions are not appreciable. In the latter case the *acceleration* of the charged particle is, as usual, proportional to the force acting on it, but in the former case the *velocity* of the particle is proportional to the acting force. Starting from this ground, expressions are easily found for the components of the velocity of the charged particle, from which it appears that in a weak magnetic field the particle moves along a line of electric force, whereas in a very strong magnetic field the particle follows a line of magnetic force. In the general case there are component forces (1) along the line of electric force, (2) along the line of magnetic force, (3) in a direction at right angles to these lines. In this case, therefore, the path of the particle is a spiral.

These results show that, if we consider ions moving with different speeds in a magnetic field of constant strength, those ions which move at high speeds will travel along the lines of magnetic force, while those which move at lower speeds move along spirals. Now in the discharge of electricity through gases the velocity of the negative ion has always been found to be greater than that of the positive ion, and this difference of velocity

has been shown to account for many of the differences between the phenomena at the positive and negative electrodes in a vacuum tube. In like manner the foregoing considerations account for the difference in behaviour of the negative glow and of the positive column in a magnetic field. In a strong magnetic field the negative glow follows the lines of magnetic force, whereas the positive column on the other hand does not do so, but follows a more or less spiral path, and this is what is indicated by the above theoretical considerations. T. P.

1897. *Hittorf's Dark Space.* **H. Ebert.** (Wied. Annalen, 69. 1. pp. 200–219, September, 1899.)—Hittorf's dark space is the narrow space immediately adjoining the luminous layer covering the kathode itself. As exhaustion proceeds, this layer increases in thickness. The author investigates the relation between the thickness of the layer and the exhaustion, and shows that the dark space increases in a geometrical series as the pressure decreases in another geometrical series, usually of different index. The relation may be put in the form—

$$\frac{d_1}{d_2} = \left(\frac{p_2}{p_1}\right)^m$$

In oxygen, a discontinuity occurs at a pressure of 0·7 mm., the point at which also a discontinuity occurs in the same gas as regards Boyle's law. E. E. F.

1898. *Diffusion of Kathode Rays.* **W. Kaufmann.** (Wied. Annalen, 69. 1. pp. 95–118, September, 1899.)—The absorption and diffusion of kathode rays by gases as observed by Lenard is studied by Perrin's electrical method. A beam of kathode rays emerging from a vacuum tube was made to traverse a metallic cylinder earthed through a galvanometer. Beyond the cylinder the rays impinged upon a metallic plate earthed through another galvanometer. Any current indicated by the first galvanometer would then be due to kathode rays absorbed or diffused in the cylinder. According to the results of Lenard, taken in conjunction with the author's own results, only a very small portion of the current is accounted for by absorption. The author finds that the quantity $\frac{bV}{p}$ is constant for any given gas, b being the diffusion, V the difference of potential, and p the pressure. It is 5,650 for nitrogen, 6,830 for CO_2, 6,380 for CO, and about 730 for hydrogen.

The author goes on to investigate the probable mechanism of the kathode rays. He concludes that the energy given off by the particles constituting them is only partly converted into

kinetic energy of the gas molecules, leading to a rise of temperature, and that the other part is converted into oscillating motion of Prout's primitive atoms. The mass of such a primitive atom would be 0·038 (H=1), and that of a radiant particle 0·00053. The hydrogen atom would thus consist of about twenty-six primitive atoms. E. E. F.

1899. *Mechanics of Kathode and Canal Rays.* **P. Ewers.** (Wied. Annalen, 69. 1. pp. 167–199, September, 1899.)—In determining the ratio e/m of the electric charge to the mass of an ion, a decided difference appears between the canal rays and the kathode rays. Whereas in canal rays the values of the ratio are quite in accordance with the supposition that projected atoms are at work, the behaviour of kathode rays does not admit that assumption. Either the mass projected would have to be 2,000 times smaller than a hydrogen atom, or an atom would have to convey a quantity of electricity 2,000 times as great as that which it is known to convey in electrolysis. The author has made a number of quantitative experiments tending to throw light on this subject. He does not share the prevalent opinion that canal rays consist of projected anode particles, since the quantity of electricity conveyed by them varies with the material of the kathode, but not with that of the anode. The author concludes that the canal rays consist of positive ions of the material of the kathode, but the matter thus conveyed to the wall is so small that it would require 288 hours of continuous working to deposit one milligramme of aluminium. About 11 to 18 per cent. of the energy supplied is given up by the canal rays in the form of heat. E. E. F.

1900. *Kathode and Canal Rays.* **O. Berg.** (Wied. Annalen, 68. 4. pp. 688–697, August, 1899.)—The author perforated the anode instead of the kathode, and obtained phenomena which are converse to those of Goldstein's canal rays, thus showing that rays from one electrode are propagated across gaps in the other. It remains certain, however, that the bulk of the work of transporting the electric charge falls to the kathode rays, and this is probably due to the fact that negative charges in a vacuum, as in the open air, are dissipated more readily than positive charges. There are other important differences. Anode rays are not capable of producing the brilliant phosphorescence obtained with kathode rays. They are, therefore, less noticed and less studied. They are not deflected magnetically to the same extent. According to Wehnelt, their direction is largely influenced by the position of the kathode, whereas kathode rays are not influenced by the situation of the anode. E. E. F.

1901. *Potential Gradient at the Anode.* **C. A. Skinner.** (Wied. Annalen, 68. 4. pp. 752–768, August, 1899.)—The potential gradient within the luminous layer immediately covering the anode is practically infinitesimal. Both Hittorf and Graham found that there was a sudden fall of potential at the anode, though not so great as that in Crookes' dark space. There is, in fact, a difference of potential between the metallic anode and the gas, amounting to, say, 20 volts. This difference increases to, say, 40 volts within the first few millimetres, but the point brought out clearly by the author is that no such increase takes place within the luminous layer immediately adjoining the anode. This luminous layer is usually 1 mm. or 2 mm. thick, and closely adheres to the anode. Another fact revealed by the author's experiments is that the greater the drop of potential at the anode, the less is the potential gradient near the anode, and the greater is the distance from the anode at which the gradient becomes constant. In other words, a great anode drop means a thick anode layer. The anode drop depends, of course, upon the gas, the pressure, and the material of the anode. Generally speaking, those metals furnish the greatest anode drop which exhibit the least difference of potential when used as kathodes. E. E. F.

1902. *Phillips' Phenomenon.* **G. W. Walker.** (Electrician, 43. pp. 602–604, 634–635, August 18 and 25, 1899.)—A mathematical investigation of the luminous phenomena in Crookes tubes described by Phillips (see 1899, Abstract No. 683). The author assumes the luminosity to be due to the collisions of negatively charged particles moving under the influence of the magnetic field. Before the magnetic field is excited the distribution of velocities will be according to Maxwell's law; but the magnetic field will give a spin to the particles, and the new distribution of velocities will cause a new arrangement of the atoms. It is shown that the gas will rotate like a solid body—a result announced independently by Kelvin; and the author investigates in what manner the gas so set in motion will, under the influence of viscosity, approach the uniform distribution of velocities in the magnetic field. The luminosity at different distances from the axis is calculated for successive stages in this process, and the results are in general agreement with the phenomenon as observed by Phillips. J. L. H.

1903. *Reflection of Hertzian Waves.* **L. De Forest.** (Amer. Journ. Sci. 8. pp. 58–71, July, 1899.)—Using an exciter which is a compromise between the Lecher and Blondlot forms, the author investigates the nature of reflection at the ends of wires arranged as in a Lecher system. He determines the end capacities for the wires with ends bare, with brass balls at the ends,

and under other conditions; the effect of bending the wires; the decrement of amplitude in the train of waves sent out; and also examines (with a coherer) the field near the wires for plane-polarised displacements. D. E. J.

1904. *Improved Lecher System.* **A. Righi.** (N. Cimento, 8. 4. pp. 34–36, 1898.)—The terminals of the exciting coil are attached to two vertical plates facing the secondary plates. The sparks of the exciter circuit pass between knots in contact with the primary plates. E. E. F.

1905. *Hertzian Oscillations.* **O. Murani.** (N. Cimento, 8. 4. pp. 36–44, 1898.)—An abstract of Murani's Istituto Lombardo paper, by Federico and Pasquini. The latter, in an additional note, confirm Murani's observation that Hertzian waves cannot be demonstrated by the coherer, since that responds to waves of all lengths. A node is shown at the mirror, and a constant deflection at any distance from it. E. E. F.

1906. *Dielectric Constants.* **W. D. Coolidge.** (Wied. Annalen, 69. 1. pp. 125–166, September, 1899.)—The author improves Drude's method of determining dielectric constants of bodies obtainable only in small quantities by introducing the condenser into the exciter circuit instead of the resonator circuit. This has the effect of considerably increasing the accuracy and sensitiveness of the method. The liquids studied included various acetates and benzoates, mixtures of ethyl ether, and chloroform, liquid chlorine, and other gases, as well as alcohol and water. The temperature coefficient of the dielectric constant of water is $-0{\cdot}432$ per cent. per degree at 17°, which is well in agreement with previous results. Water shows anomalous dispersion of electric waves, but alcohol shows no electric dispersion at all. E. E. F.

1907. *Deformation of Dielectrics.* **P. Sacerdote.** (Comptes Rendus, 129. pp. 282–285, July 31, 1899.)—The author derives the formulæ expressing the electric deformation of dielectrics from the fundamental principles of electricity and the conservation of energy. He shows that all deviations from these formulæ are due to experimental errors. He finds that dilatation is the same in all directions normal to the lines of force, whatever be the shape and size of the condenser. As regards the causes of the dilatation, the author seeks them in the elastic deformation due to the known electric forces, and in a change of molecular state

in the dielectric due to the ether disturbance. In gases the latter cause alone is at work, and brings about the electric contraction observed in them. E. E. F.

1908. *Polarisation of Dielectrics.* **F. Beaulard.** (Comptes Rendus, 129. pp. 149–152, July 17, 1899.) — According to Poisson's formula $\mu = \frac{1+2g}{1-g}$, where μ is the magnetic permeability, and g the ratio between the space actually occupied by magnetic particles (assumed spherical and of infinite permeability, disseminated throughout a non-magnetic medium) and the total volume of the substance. But in iron, if $\mu = 500$, g is greater than the maximum possible ratio $n/(3\sqrt{2})$. Maxwell pointed this out: Betti makes $k = (\mu - 1)/4\pi \{ = 3g/4\pi(1 - 3g) \}$ instead of $k = 3g/\{4\pi(1-g)\}$; whence $\mu = (1 - 3g)^{-1}$; which gives possible values. Mossotti has applied the same order of ideas in electrostatic induction, K corresponding to μ; and Clausius has reached a result the same as that of Poisson, K replacing μ. Experiment shows that the Clausius and Betti formulæ equally well represent the facts. With mixtures of copper filings and paraffin, the specific inductive capacity *increases* as the proportion of copper is increased: this is contrary to the Maxwellian doctrine that it is zero for perfect conductors. **Potier** writes that the electromotive force at a point is equal to the sum of the electromotive forces which produce the currents of conduction and of displacement, and obtains the relation—

$$P = \frac{u}{c} + \frac{4\pi f}{K},$$

which for a conductor makes $K = \infty$. A. D.

1909. *Flow of Electrolytes through Partitions.* **F. T. Trouton.** (Electrician, 43. pp. 596-597, August 18, 1899.) — A beaker, pierced by a small hole, is placed in a second vessel, and both are filled with dilute acid. A lead plate in each serve as electrodes. When a current passes between the electrodes, the liquid rises in one or other of the vessels. Reversal of the current does not reverse the direction of the flow of the electrolyte. Any obstruction placed near the hole on one side or the other predisposes the level to rise on that side. At first the rate of rise is slight, but it increases, and the vessel from which the liquid is flowing is rapidly emptied, *i.e.*, the flow increases as the difference of level increases, and against the hydrostatic pressure. The action appears to be accompanied by an intermittent arc at the perforation, but this part of the phenomenon is not clearly described. The liquid is forced from the lower to the higher level by the formation of bubbles of vapour periodically at the

perforation, on the side where the hydrostatic pressure is least, that is towards the lower level. The direction of flow depends upon which side of the hole the bubbles are formed. If a more dilute acid is placed on one side, the vapour tension is greater on that side, the bubbles form there more easily, and the flow is towards the denser side. The flow is always towards the side where bubbles are formed with most difficulty. R. A.

1910. *Electrolytic Conductivity of Solids at High Temperatures.* **W. Nernst.** (Zeitschr. Elektrochem. 6. pp. 41–43, July 13, 1899.)—The conductivities of rods composed of different metallic oxides or mixtures of oxides is investigated at different temperatures. The heating is done in a small electric oven and the temperature is measured by a platinum — platinumrhodium couple.

The conductivity of pure oxides increases very slowly with the temperature and also remains relatively small, while that of mixtures of oxides is of very much greater magnitude. [No numerical figures are given.] In order to test the conductivity at much higher temperatures, the rods are heated to incandescence by a current sent through them. The temperature can then be only roughly guessed at. The conductivities of mixtures of oxides, especially of those of Mg, Si, Zr, and the other rare earths are then found to be very great, a conductivity equal to that of the best conducting sulphuric acid solution being measured. At first alternating currents were used, but later it was found that continuous currents could keep one of the rods incandescent for hundreds of hours, without causing any disturbing decomposition. That the conduction is electrolytic and not metallic is evidenced by a number of considerations.

The transparency to light of all the oxides used is opposed to metallic conductivity. The author considers this a crucial test in all cases and applies it to the electric arc, and to the deep blue solution of Na in liquid ammonia, to both of which metallic conduction has been ascribed.

Mixtures of coloured oxides such as those of iron and cerium show a wandering of colour towards the kathode. Rods which contain much magnesia show quite appreciable growths at the kathode due to the burning of the magnesium formed there. Rods which are kept incandescent by continuous currents for a time show decided polarity, the kathode being always less bright than the anode. This is due to the rod becoming richer in the conducting material (dissolved oxide) near the kathode and poorer nearer the anode, consequently offering a higher resistance to the current near the latter. This unequal distribution only results to a certain extent, as diffusion, which tends to equalise matters, introduces a stationary condition. J. B. H.

1911. *Measurement of Self-Induction.* **G. W. Patterson.** (Wied. Annalen, 69. 1. pp. 34–65, September, 1899.) — The author compares the efficiency of two different methods of measuring self-induction—that of Maxwell as improved by Rayleigh, and that of Oberbeck, in which the coil of known resistance and unknown self-induction forms one branch of a Wheatstone bridge, the coil of an electrodynamometer takes the place of the galvanometer, and a zinc inductor that of the battery. The Maxwell-Rayleigh method requires accurately known resistances, a good ballistic galvanometer, and a constant temperature. The accuracy of the resistances and the constancy of the temperature are not so essential in Oberbeck's method, but the latter requires a sensitive electrodynamometer of rather high resistance and low inductance, and a constant source of sinusoïdal E.M.F. Oberbeck's method has the advantage of being in a certain sense a null method, since two points of equilibrium must be obtained, one with a continuous and the other with an alternating current, corresponding to the two enduring and two ballistic deflections in the other method. On the other hand, a galvanometer is far superior to an electrodynamometer in sensitiveness when the latter contains no iron, and iron is excluded by the fact that its presence would make the self-induction a function of the current. In the case of very small self-inductions, the joulean heat developed renders the Maxwell-Rayleigh method inaccurate. E. E. F.

1912. *Conductivity of Lead Peroxide.* **T. Sundorph.** (Wied. Annalen, 69. 1. pp. 319–323, September, 1899.)— Peroxide of lead, when used as a coherer substance, decreases in conductivity under the impact of electric waves. In one experiment the current decreased from 8·5 to 5 milliamperes in twenty minutes. At the same time the amount of PbO_2 was slightly reduced, but the author gives no explanation of this reduction. He observed that whatever took place was confined to the neighbourhood of the two terminals, and that the positive pole became hotter than the negative pole. E. E. F.

1913. *Measurement of Resistance by Damping.* **R. H. Weber.** (Wied. Annalen, 68. 4. pp. 705–728, August, 1899.)— In measurements of the resistivity of bodies like copper-zinc alloys containing more zinc than copper, it is impossible to obtain the substance in a form suitable for testing by the ordinary methods, owing to the brittleness of the alloys of that composition. The author has, therefore, worked out a new method, in which the material can be used in the form of plates or thick cylinders. Either a magnet is made to vibrate over a disc made of the alloy, or a cylinder of it is made to oscillate in

a magnetic field. The damping produced by the induced currents forms a measure of the specific resistance, the logarithmic decrement being directly proportional to the conductivity. The accuracy is considerable, the errors not exceeding 0·7 per cent. in the case of alloys and amalgams. A further advantage of the method is that the material examined need not be subjected to strong mechanical manipulation such as is, for instance, involved in wire-drawing. A somewhat modified method consists in observing the deflection of the body in a rotating field. This is not quite so satisfactory, owing to the slipping of the zero, but it has the advantage of being suitable for electrolytes as well as for metals. E. E. F.

1914. *Insulation of Three-Wire System.* **J. Kollert.** (Elektrotechn. Ztschr. 20. pp. 179–180, 1899.)—The author gives a method of finding inferior limits of the insulation resistances of the three wires taken separately when a galvanometer of known constant is introduced between each wire separately and earth, and the current strength is observed in each case. E. E. F.

1915. *Influence Machine.* **W. R. Pidgeon.** (Phil. Mag. 46. pp. 564–567, 1898)—This is a simple machine in which each sector is embedded in an insulator, with the exception of a brass contact knob. It therefore carries a double charge, and the machine is, for the same surface, four times as effective as a Wimshurst machine. E. E. F.

1916. *Wehnelt Interrupter.* **W. J. Humphreys.** (Phys. Rev. 9. pp. 30–40, July, 1899.)—As negative electrodes, sheets of lead, copper, amalgamated copper, and coils of copper wire may be used with equal success. As positive electrodes, platinum wire or foil may be used; but the larger the exposed positive surface, the more current is necessary, the less frequent are the interruptions, and the greater the intensity of the secondary discharge. The distance between the electrodes is practically unimportant, and their relative positions are unimportant provided that the gases formed at the positive electrode can be easily and quickly replaced by the electrolyte. The platinum wire forming the positive electrode is held in a tube of soft German glass, external contact being made by mercury within the tube; to prevent subsequent cracking, the platinum is sealed into the tube with a bead of blue enamel glass. After long use, that part of the platinum which is in the electrolyte becomes pitted and frosted; and the part in contact with mercury within the tube becomes very perfectly amalgamated. The

author ascribes the pitting to the action of electric discharges. Those electrolytes that conduct best give the best results with the interrupter, they also give the most vigorous action when their concentrations are such as to give the best conductivities at the temperature at which they are used. To prevent acid spray and change of bulk of the electrolyte, a layer of paraffin oil should be poured over the surface; the electrodes may be dipped in and out through the oil without hindrance to the efficiency of the interrupter. When there is no glow the current is not interrupted; but when there is no break there may still be a glow on a part of the anode, suggestive of brush discharges. Examined with a revolving mirror, the glow is seen to be intermittent with total absence of light at the intervals. The spectrum shows the lines of hydrogen and oxygen. Interruption is disturbed by a strong magnetic field; and may be completely stopped until the applied volts are increased. Increase of hydrostatic pressure lowers the frequency. The gases generated are different from those obtained by quiet electrolysis; there is a relatively small proportion of oxygen. As regards self-starting, if the voltage is just enough to work the interrupter the action begins wherever the circuit is closed; if the voltage is high, the electrode must be immersed before closing the circuit. The positive electrode has three stable conditions of activity: (1) the high-resistance stage, corresponding to very small currents; (2) quiet electrolysis; (3) the stage of regular interruption, corresponding to large currents. With very small self-induction, the action can only be obtained with very small anodes. Decrease in the self-induction causes increase in average current. For X-ray work the best results are obtained with an interrupter giving a frequency of about 300 per second; higher frequencies cause the tube to light up throughout. The author suggests that the action of the interrupter depends upon electrical discharges. The current first increases, on account of the self-induction, until the electrode is completely sheathed by a layer of gas, almost entirely oxygen. This gas abruptly breaks the circuit, and owing to the self-induction there is now an electrical discharge across the layer, giving rise to the glow, and at the same time decomposing some of the liquid. The sudden freeing of these gases and the heat of the discharge together produce an explosive effect; when this is over, the liquid falls back to its place, and the action is continued. R. A.

1917. *Wehnelt Interrupter.* **É. Hospitalier.** (Soc. Int. Elect. Bull. 16. pp. 248–255, 1899.)—This is a summary of the work done on the Wehnelt interrupter up to April last, together with a description of some original experiments. E. E. F.

1918. *Caldwell Interrupter.* **A. G. Cooke.** (Elect. Rev. 44. pp. 888–889, June 2, 1899.)—In the modified Wehnelt interrupter designed by Caldwell and Simon, the small orifices are gradually enlarged, the glass presenting a ground appearance. At the same time, acid is drawn through from the larger into the smaller partition. E. E. F.

1919. *Wehnelt Interrupter.* **H. T. Simon.** (Wied. Annalen, 68. 4. pp. 860–868, August, 1899.)—The form of interrupter described consists of a lead vessel filled with dilute sulphuric acid. An ordinary wide test-tube, attached to an ebonite lid, projects down into the acid. It contains a cylinder of sheet-lead, serving as a second electrode, and the bottom of the test-tube has several perforations about 1 mm. wide. In another form of the apparatus, a rectangular glass vessel is divided into two partitions by means of a thin plate of glass containing a few perforations. The two partitions contain electrodes identical in shape. In a third form, which, however, is of more theoretical than practical interest, the two vessels are joined by an inverted **U**-tube containing liquid nearly interrupted by a bubble at the top. The second type is that usually adopted. Slits may be substituted for the holes. The interrupter operates equally well for continuous and alternate currents, and interrupts both phases of the latter. It is not spoilt by the heat developed. E. E. F.

1920. *Instantaneous Contact-Maker.* **J. Haralson, Jr.** (Elect. World and Engineer, 34. pp. 83–84, July 15, 1899.)—A hard rubber disc is attached to one end of a shaft, the other end of which is attached to the shaft of the machine to be tested by means of a universal joint. A cast-iron ring is attached to the disc, and in an opening in this ring is placed a piece of steel spring embedded in fibre. This piece of spring is connected by a wire to a brass ring fitted over the hard rubber disc. A brush bearing on this brass ring is therefore in continuous connection with the steel spring. Another brush bearing on the cast-iron ring makes contact with the spring once in a revolution. To take a curve of E.M.F., the instantaneous E.M.F. of the machine is compensated by a potentiometer, equality being indicated by the absence of noise in a telephone receiver.
E. E. F.

1921. *Cadmium Standard Cells.* **J. Henderson.** (Phil. Mag. 48. pp. 152–156, July, 1899.)—The author investigates how far reliance may be placed in cells constructed from "pure" materials, though not specially purified; also the effect of using moist crystals in place of solution, and acid salts instead

of neutral salts. "Crystal" cells were found to be satisfactory, but not those containing solution. The author concludes that the cadmium cell is superior to the Clark cell. The effect of ordinary impurities is small, except free acid. It does not matter whether acid or neutral salts are employed. The mean temperature coefficient was found to be 0·005 per cent. per 1° C. Sudden variation of temperature should be avoided on account of time-lag. Depolarisation is rapid. W. R. C.

1922. *Magnetic Properties of Inorganic Compounds.* **S. Meyer.** (Wied. Annalen, 69. 1. pp. 236–263, September, 1899.)—The author has extended his magnetic researches to some 200 inorganic compounds of all the known elements. From the material thus accumulated he draws some important conclusions. The combination of two diamagnetic elements is always itself diamagnetic. Certain apparent exceptions are due to impurities. Compounds consisting of paramagnetic elements are not, however, necessarily paramagnetic. Thus the oxides of magnesium, aluminium, tungsten, thorium, and silicon are diamagnetic, and this cannot be explained by impurities. In any case it is not permissible to infer the magnetism of an atom from that of the molecule it helps to constitute. Polonium and radium are paramagnetic. The author has discovered quite a series of strongly magnetic elements, represented by the symbols, Pr, Nd, Yb, Sa, Gd, and Er. The last of these, erbium, shows in the form of the oxide a magnetic permeability four times that of Fe_2O_3. If the metal is more strongly magnetic in the same proportion as its oxide, a very important addition to our magnetic resources will have been made. As a rule, the molecular magnetism of paramagnetic compounds is smaller than the sum of the atomic magnetisms. In diamagnetic compounds the magnetism is simply additive. The author admits that valuable conclusions may be drawn from the magnetism of an element as to its molecular weight, and he expects that the molecular weights of radium and polonium will be found to be somewhere about 180, or above 230. E. E. F.

1923. *Magnetic Field within a Tubular Current.* **W. de Nikolaieve.** (Comptes Rendus, 129. pp. 202–203, July 24, 1899.)—Experiment shows that a magnetic pole placed within a tubular current experiences a magnetic couple. A. D.

1924. *Magnetic Properties of Hematite.* **A. Abt.** (Wied. Annalen, 68. 4. pp. 658–673, August, 1899.)—The hematite was derived from the neighbourhood of the great deposit of magnetite

at Vaskö, Moravitza. Rough preliminary measurements revealed the fact that similar pieces of magnetite and hæmatite, subjected to the same magnetising current, gave deflections of the magnetometer standing in the ratio of 4 to 1. More detailed measurements showed that both the maximum magnetisation and the remanent magnetism of hematite depend largely upon the structure of the ore. One particularly homogeneous specimen, showing a percentage of iron rather in excess of that indicated by the formula Fe_2O_3, exhibited a remanent magnetism approaching that of magnetic iron ore within some 70 per cent. The maximum magnetic moments of three equal prisms, of pyrrhotite, hematite, and magnetite respectively, were found to be in the ratio of 1 to 2·356 to 3·237.

Pyrrhotite shows the smallest magnetisation in comparison with its percentage of metallic iron. In hematite, as in steel and in magnetite, the intensity of magnetisation increases with the length of the rod. E. E. F.

1925. *Hysteresis at Low Temperatures.* **A. H. Ford.** (Elect. World and Engineer, 34. p. 195, August 5, 1899.)—A sample of transformer iron was tested for hysteresis with a Ewing hysteresis tester at the ordinary temperature of the room. It was then plunged into a beaker of liquid air, allowed to cool, quickly removed, and tested while cold. Finally, another test was taken when the iron had attained the ordinary temperature. Four samples of the same kind of iron were examined in this way, and the mean results, giving the hysteresis loss in ergs per cycle per cubic cm., at the density of one gauss, were as follows:—

		% Increase.
Initial	0·00124	
Cold	0·00159	28
After warming	0·00139	12

Some other samples of the same kind of iron showed the following effect of heat treatment:—

		Hysteresis Loss.
Annealed from	835° C.	0·0014
Quenched in water from	225° C.	0·00125
Quenched in water from	400° C.	0·00145
Quenched in water from	804° C.	0·00150

A. H.

1926. *Normal Curve of Magnetisation of Iron.* **W. S. Franklin** and **S. S. Clarke.** (Phys. Rev. 8. pp. 304–309, 1899.)—It is likely that there are three distinct magnetising forces holding each other in equilibrium in a specimen of magnetised iron, viz.:—

(*a*) The impressed magnetising force including the demagnetising force due to the free magnetic poles of the specimen.

(*b*) A coercive or hysteretic magnetising or demagnetising force due to magnetic lag as the specimen is brought from one magnetic state to another.

(*c*) A demagnetising force due to a store of recoverable potential energy in the iron, or rather to a store of magnetic energy which is not yet dissipated by hysteresis. Thus, if V is the amount of this undissipated magnetic energy per unit volume, then V is a function of B, and $\frac{dV}{dB}$ is the demagnetising force due to V.

The function V may be determined indirectly by determining the curve of magnetisation under conditions in which the coercive or hysteretic force is obliterated, for, in this case the impressed magnetising force H and the demagnetising force $\frac{dV}{dB}$ are at each step in equilibrium, so that the curve of B and H obtained becomes the curve of B and $\frac{dV}{dB}$. This curve the authors call the *normal curve of magnetisation.*

Two methods are employed for the obliteration of the coercive force in the determination of $\frac{dV}{dB}$. In one method the iron specimen is subjected to the process of demagnetisation by reversals at each step. In the other method the iron specimen, which is in the form of a wire, is stretched by a constant force and set into violent longitudinal vibrations before each set of readings of B and H. For large impressed magnetising forces the operation of demagnetisation by reversals does not entirely obliterate coercive force.

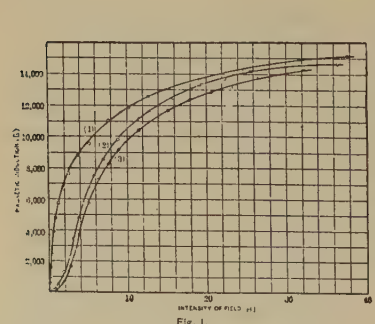


Fig. 1.

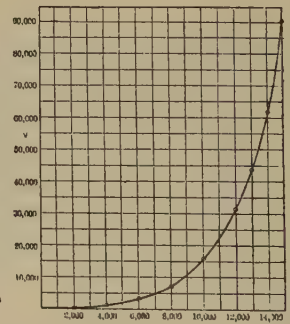
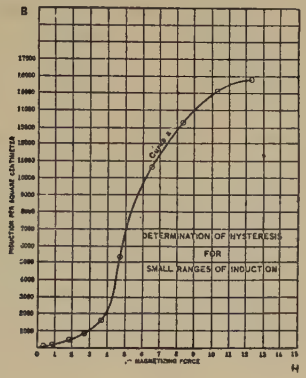


Fig. 2.

In the figures curve 1 gives the results obtained when at each step the specimen is subjected to the operation of demagnetisation by reversals. Curve 2 gives the results when subjected to violent longitudinal vibrations. Curve 3 gives the results when the specimen was magnetised in the ordinary way from a neutral

condition. The curve in figure 2 gives the values of the energy function V for various values of B as determined by integrating the curve 1. W. G. R.

1927. *Hysteresis Loss for Small Induction.* **H. S. Webb.** (Phys. Rev. 8. pp. 310–314, 1899.)—The method used for determining the hysteresis loss is due to W. S. Franklin, and consists in weighing by a balance the force necessary to reverse



the magnetism in the iron. The energy per cubic centimeter lost in the iron in one cycle is equal to the force measured by the balance in dynes divided by the area of the iron specimen.

The results obtained are embodied in curves, one of which is reproduced. W. G. R.

1928. *Magnetism and Molecular Rotation.* **Kelvin.** (Phil. Mag. 48. pp. 236–239, August, 1899.)—The author, in the light of Zeeman's experiments, renounces the old tempting gyrostatic hypothesis on the ground that no simplifying suppositions as to the character of the molecule, such as symmetry of forces and moments of inertia round the axis of the ring, can possibly give Zeeman's normal result of the splitting of a bright line into two sharp lines circularly polarised in opposite directions, when viewed parallel to the lines of force. Lorentz's theory, as expressed in Zeeman's first paper, he regards as essentially true. But he develops a novel conception of the magnetic molecule which goes some way towards accounting for the phenomena of diamagnetism. Each molecule is figured as an endless tube of non-conducting matter, "vitreously" electrified, and filled with an incompressible non-conducting fluid charged with an equal quantity of "resinous" electricity. In a magnetic field the fluid and the tube will experience equal and opposite tangential forces, and the tube will give rise to ether waves, while the fluid will

rotate and continue rotating as long as the field is constant. This rotation, however, constitutes kinetic energy, and hence the field will contain more energy where it is strong than where it is feeble, and the molecules will crowd towards the feebler portions of the field. E. E. F.

1929. *Magnetic Transformation-point of Nickel Alloys.* **L. Dumas.** (Comptes Rendus, 129, pp. 42–45, July 3, 1899.)—Alloys of nickel with carbon, silicium, manganese, and chromium are examined with respect to their magnetic permanence and non-permanence at the three selected temperatures 15° C. – 78° C. and – 188° C. The results are tabulated in a form giving the constitution of each nickel alloy, and a qualitative statement as to whether its magnetisation at those temperatures is permanent, non-permanent, strong, feeble, or zero. Having regard to the constitution of the alloys, it is seen that the point of transformation from permanence to non-permanence depends not only upon the proportion of nickel, but also upon the temperature. The point of transformation can be lowered by the addition of carbon or manganese. Certain steels having more than 24 per cent. of nickel are non-permanent at low temperatures, others acquire permanence at low temperatures. One of these alloys is marked "permanent" at 15° C. "non-permanent" at – 78° C. and again "permanent" at – 188° C. Carbon clearly preponderates in the power of bringing about this kind of change, especially when combined with chromium. R. A.

1930. *Magnetic Pyrites.* **G. Sagnac.** (Paris, Soc. Franc. Phys. Bull. 131. pp. 4–5, 1899.)—Apparatus described, devised by M. Weiss, for showing that magnetic pyrites has two rectangular directions, of which one is magnetic, the other not. (See also 1899, Abstract No. 713.) A. D.

1931. *Magnetism and the Thermoelectric Properties of Bismuth and its Alloys.* **G. Spadavecchia.** (N. Cimento, 9. pp. 432–446, June, 1899.)—Variations in the thermoelectric E.M.F. of the alloys of bismuth and tin under the influence of a magnetic field increase with increase of the variations in that field, and have different values according to the direction of the magnetisation. Under the influence of a given magnetic field the variations of the thermoelectric E.M.F. diminish from pure bismuth to an alloy containing 0·113 per cent. of tin, changing sign between 0·056 per cent. and 0·113 per cent.; then the variations increase up to 0·237 per cent., changing sign between this and 2 per cent. The sign changes again for an alloy between 80 and 83 per cent. of tin. A. D.

1932. *Comparison of Magnetic Instruments.* **L. Palazzo.** (Roma R. Accad. Lincei Atti, 8. pp. 386–392 and 443–447, 1899.)—This is the report of the Italian Commissioner who carried out a comparison of the instruments used in the magnetic survey of Italy with those of Parc Saint-Maur and Kew. The following are the differences in the readings, as observed when simultaneous readings were taken with the instruments in question :—

	Rome—Parc Saint-Maur.	Rome—Kew.
Declination	$+0'\cdot6$	$-0'\cdot7$
Dip	$-1'\cdot2$	$-0'\cdot7$
Horizontal Force...	$-0\cdot00009$	$-0\cdot00006$

E. E. F.

1933. *Magnetometer Observations and Atmospheric Pressure.* **G. Bellagamba.** (Roma R. Accad. Lincei Atti, 8. pp. 529–534, June, 1899.)—The time of vibration of a suspended magnet depends to some extent on the barometric pressure, as is proved by putting the magnet in an air-tight box, and varying the pressure by means of a pump. The variations, proportionately greater with a light than with a heavy magnet, are so small as to be negligible in determinations of the horizontal intensity of the earth's magnetic field. A. Gs.

1934. *Magnetic Elements of Potsdam.* **M. Eschenhagen.** (Wied. Annalen, 68. 4. pp. 917–918, August, 1899.)—The mean values for 1898 were computed from the hourly values of all days. They are as follows :—

	1898.	Difference : 1898–1897.
Declination	$10°\ 5'\cdot0$ W.	$-4'\cdot7$
Horizontal Force	0·18794 c.g.s.	+0·00019 c.g.s.
Vertical Force	0·43408 c.g.s.	+0·00010 c.g.s.
Dip	$66°\ 35'\cdot3$ N.	$-1'\cdot0$
Total Force	0·47302 c.g.s.	+0·00016 c.g.s.

Pronounced disturbances were observed on March 15th and 16th, and September 9th, and minor ones on fourteen other days. The disturbances show an increase over last year. E. E. F.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1935. *Transition-Points.* **H. Le Chatelier.** (Comptes Rendus, 129. pp. 497–499, September 25, 1899.)—The author states that the existence of fixed transition-points and fixed tensions of dissociation are more a matter of theory than of experiment, and points out that the phase rule cannot be applied directly to infinitesimal quantities of substance where the internal pressure on a particle, due to surface tension, depends largely on the magnitude of the particle. T. M. L.

1936. *Electrical Reaction-Velocity.* **E. Cohen.** (Zeitschr. Elektrochem. 6. pp. 85–87, July 27, 1899.)—If two elements are placed in circuit, each with one electrode reversible as to the anion, and the other electrode reversible as to the cation, and differing only in that the electrolytic salt-solution is saturated with regard to the stable form of the salt in one element, but with regard to a metastable form in the other, the resultant (differential) E.M.F. of the combination affords an electrical measure of the maximal energy liberated in the change from the metastable to the stable form of the salt. Thus in the case of two Clark elements, one saturated with regard to the salt $ZnSO_4\,7\,H_2O$, and the other with regard to the salt $ZnSO_4 . 6\,H_2O$, there is a difference of E.M.F. which increases from o at $+39°$ C. to 16·2 millivolts at $-5°$ (Jäeger, Wied. Ann. 63. 345, 1897). The velocity of change is proportional to the current $C = E/\Sigma R$. The author has shown (Zeit. Phys. Chem. 1899, 28. 723) that the resistance of a Clark cell is proportional to that of a saturated solution of zinc sulphate at the same temperature, and therefore for two cells of equal dimensions $C = E/k\ (\omega_1 + \omega_2)$, where $\omega_1\ \omega_2$ are the specific resistances of a zinc sulphate solution saturated with regard to the salts $ZnSO_4 . 7H_2O$ and $ZnSO_4 . 6H_2O$. At the transition-point, 39° C., both salts are equally soluble and $\omega_1 = \omega_2 = 0{\cdot}0237$; below the transition-point the salt $ZnSO_4 . 7H_2O$ is less soluble, and ω_1 increases steadily to 0·0491 at $-5°$, whilst ω_2 increases to 0·0577. The electrical velocity-constant is $C' = E/(\omega_1 + \omega_2)$, and when calculated from this formula is found to rise from o at 39° to a maximum value $C' = 167{\cdot}6$ at 9°, and then to decrease to $C' = 151{\cdot}7$ at $-5°$. The occurrence of a maximum velocity of change is in accordance with the similar observations of Tammann (Zeit. Phys. Chem. 23. 326, 1888), on the velocity of crystallisation of supercooled liquids. T. M. L.

1937. *Electrical Determination of Saturation-Point of Solutions.* **J. H. van't Hoff.** (Zeitschr. Elektrochem. 6. p. 57–61, July 20, 1899.)—In this paper, read before the annual meeting of the German Electrochemical Society, the author describes a method, based upon the experiments of Dawson and Chiacaviglio, for determining the saturation-point of solutions of two or more salts, such as magnesium chloride and magnesium sulphate, with the corresponding sodium and potassium salts. The disadvantage of the usual specific gravity method of determining this point is, that the variation of specific gravity is slight for considerable difference of composition; and under certain conditions the specific gravity determination leads to incorrect conclusions as to the relative percentage of salts in solution.

The new method consists in measuring the electrical resistance of the solution, at intervals, between two fixed platinum electrodes. This method gives a much wider range of variation for mixed salt solutions of varying degrees of saturation, but is not free from the objection that at times solutions of different composition give the same electrical resistance. The author is now experimenting with a modification of the method in which the difference of potential between a mercury anode and calcium kathode is taken. Drawings of the apparatus used are given.

J. B. C. K.

1938. *Hydrolysis of Stannic Chloride.* **W. Foster, Jr.** (Phys. Rev. 9. pp. 41–56, July, 1899.)—The conductivity of solutions of stannic chloride in water is found to increase with time, becoming constant in fairly dilute solutions at values approximately the same as that of equivalent HCl solutions, whence complete hydrolysis is inferred. The change is rapid at high dilutions (complete in two or three hours), and slower at medium concentration, but strong solutions are already constant before they can be measured. The molecular depression of freezing-point found by Loomis agrees with the above assumption.

B. B. T.

1939. *Influence of Pressure on Formation of Tachydrite.* ($CaCl_2 . 2\,MgCl_2 . 12\,H_2O$.) **J. H. van't Hoff** and **H. M. Dawson.** (Berlin Akad. Sitzber. 30. pp. 557–562, June 15, 1899.)—This investigation forms one of a series of researches which are being carried out with a view to explaining the formation of the Stassfurt salt deposits. The influence of pressure on the nature of the deposited salts has been here investigated, and for this purpose tachydrite ($CaCl_2 . 2\,MgCl_2 . 12\,H_2O$) was specially chosen, since it is formed from its components at the very convenient temperature of 22° C.

The temperature of formation of tachydrite under atmospheric pressure has been determined very accurately by the thermometric

method, two experiments giving respectively 22·4 and 22·399° C. The influence of pressure was measured in the manokryometer, in which the pressure on the system is attained by means of the expansion accompanying the formation of tachydrite from its components, the result being a state of equilibrium between the tachydrite and the partially transformed $MgCl_2 . 6 H_2O$ and $CaCl_2 . 6 H_2O$. After a dilatometric determination of the temperature of formation under atmospheric pressure by working with the open manokryometer, the latter was closed, the temperature of the bath raised, and the pressure corresponding to the condition of equilibrium at this temperature was determined by reading off the volume occupied by the enclosed air column. The mean result is that the temperature of formation of tachydrite is raised 0·017° C. by an increase of pressure equal to 1 atmosphere.

The authors point out that, from thermodynamical considerations, the influence of pressure on the formation of other minerals occurring in the Stassfurt deposits must be of the same order of magnitude; and that, in comparison with the influence of temperature, the pressure exerts but little effect on the crystallisation which results in the formation of oceanic salt deposits. Assuming a maximum pressure of 180 atmospheres, the effect of the latter in the case of tachydrite corresponds to a variation in the temperature of only 3° C. J. B. H.

1940. *Dissociation and Dielectric Constants.* **H. Euler.** (Zeitschr. Phys. Chem. 28. pp. 619–628, 1899.)—Polymerised bodies possess as a rule high dielectric constants. A case is quoted in which the molecular conductivity of a salt diminishes as dilution increases, and the author attempts to show that the dissociating force increases with the number of ions in the solution. E. E. F.

1941. *Electrolytic Evolution of Hydrogen.* **A. Coehn.** (Zeitschr. Elektrochem. 6. pp. 37–41, July 13, 1899.)—The electromotive force necessary to electrolyse water so as to cause bubbles of gas to be given off must exceed a certain minimum, this minimum depending on the metal of the electrodes. Caspari has carried out an investigation on this subject, the results of which have not yet been published, but Coehn gives here a few of them.

The E.M.F.s measured between the cathode of the metal and a constant hydrogen electrode, when bubbles of hydrogen are beginning to form, are as follows :—

Pt (platinised)...	0·005	Pd.....	0·48
Au	0·02	Sn.....	0·53
Pt (ordinary) ...	0·09	Pb.....	0·64
Ag	0·15	Zn.....	0·70
Cu	0·23	Hg	0·78

Were the evolution of hydrogen a reversible phenomenon these numbers would in every case be zero, while the difference of potential between the hydrogen electrode and the anode would be 1·08 volts. It is evident that with platinised platinum the condition of reversibility is practically fulfilled.

Coehn has already given an expression for the condition that hydrogen bubbles should be evolved in the case when the action is reversible. He now introduces into this expression another factor for the above excess E.M.F. which prevents reversibility, and in the expression so modified he considers the effects produced by varying the various factors, such as concentration of the ions of H, or the ions of the metal in salt solutions, the osmotic pressure, &c. He illustrates by means of the formula the different ways of preventing the solution of zinc in sulphuric acid solution :—By diluting the acid ; by amalgamating the zinc ; by introducing $ZnSO_4$. He also illustrates the fact that lead can be deposited electrolytically from an acid solution, while zinc cannot be so deposited.

The particular property of the metal on which he considers the excess E.M.F. depends is the solubility of hydrogen in the metal.

Ostwald, in his discussion, attributes the excess E.M.F. entirely to the surface of the metal, and is led to this conclusion by the fact that with liquid electrodes the same value of this excess E.M.F. is obtained with amalgams of Zn, Cd, &c. as with pure Hg. If electrolysis is carried on very slowly, he considers a continuous state of things may be kept up by diffusion without any hydrogen bubbles being liberated at the kathode. If, however, bubbles are to be liberated, a certain extra amount of work will be required to supply the energy necessary to create the first small bubble. Assuming the first bubble to have infinitesimal dimensions, an infinite pressure would be required, and infinite supersaturation. Assuming molecular dimensions only, the necessary supersaturation is beyond all known limits, but the potential comes out less than that experimentally determined for Hg.

Ostwald thinks that velocity must enter into the question, and that different values of the potential necessary to form the first bubble would be obtained with different time limits. It is possible that the H, which has been separated out as ions, has no charge at first, and that the reaction $2H = H_2$ in the dissolved state takes some time. Then this single atom H would have greater solubility in the liquid and a much smaller super-pressure of solution or super-saturation would be necessary to give the same potential.

Bredig attributes the phenomenon to combination of the H with the metal of the kathode similar to the combination of a Na kathion with the metal of the kathode which he proved to occur with heavy current densities. J. B. H.

1942. *Electrolysis away from Electrodes.* **F. T. Trouton.** (Electrician, 43. p. 294, June 23, 1899.)—Two beakers, one placed within the other, contain the electrolyte, and one electrode is placed in each. The inner beaker is perforated with a small hole, so that the arrangement practically forms a Caldwell interrupter. When a current passes at a minimum pressure of 800 volts continuous, or 500 volts alternating, a blue glow appears, and oxygen and hydrogen are evolved at the hole. The continuous currents varied between 0·3 and 0·08 ampere. The oxygen always appeared in the inner beaker, no matter what the direction of the current. W. R. C.

1943. *Organic Electrolysis by Alternating Currents.* **M. Krüger.** (Elektrochem. Ztschr. 6. pp. 29–32, 1899.)—This is a short summary of the work of Drechsel and Gerbes on the effect of alternate-current electrolysis on ammonium carbamate, and that of the former author on its effect on certain other organic solutions, with a hypothetical explanation of the action. W. G. M.

1944. *Electrolysis of Platinum Chloride.* **W. Dittenberger and R. Dietz.** (Wied. Annalen, 68. 4. pp. 853–859, August, 1899.)—The authors tested Kohlrausch's supposition that platinum chloride in solution takes the form H_2PtCl_4O, and that during electrolysis it splits up into the ions H_2 and $PtCl_4O$, the metal thus going to the anode. They consider it more probable that chloroplatinic acid is formed (which possesses a much higher conductivity than fresh platinum chloride solution) according to the formula, $2\ H_2PtCl_4O = H_2PtCl_6 + PtCl_2O + H_2O$. Stannic chloride also shows an anomalous behaviour of this kind, a small amount of tin being conveyed to the anode.
E. E. F.

1945. *Electrolysis of Hydrochloric Acid.* **D. Tommasi.** (Elect. Rev. 45. pp. 469–470, September 22, 1899.)—Electrolysing hydrochloric acid with currents at 1·02, 1·42, and 2·04 volts, the author observed that the platinum anode is dissolved only in concentrated HCl of density 1·2. Diluted acids yielded oxides of chlorine, about which no particulars are stated. H. B.

1946. *Electrolysis of Alkali Chloride Solutions.* **Foerster.** (Zeitschr. Elektrochem. 6. pp. 11–26, July 6, 1899.)—In this paper, read before the annual meeting of the German Electrochemical Society, Foerster reviews the experimental work of

Fogh, Oettel, Haber, Wohlwill (see 1899, Abstract No. 341), Winteler (see 1899, Abstract No. 1407), and Muller (see 1899, Abstract No. 1408), and discusses the results obtained by them in their relation to those obtained by Jorre and himself. The paper is unsuited for useful abstraction; but Foerster thus summarises the bearing of these researches upon the industrial utilisation of electrolysis for chlorate production :—

1. The reduction at the kathode should be minimised as far as possible, either by formation of a skin of calcium hydrate or by the use of potassium chromate. (See Muller's researches.)

2. The electrolyte should be slightly acid, in order that free hypochlorous acid may be produced.

3. A large volume of electrolyte should be used, and it should be constantly agitated, in order to promote those secondary reactions requiring time for their completion.

4. A temperature of at least 40° C. should be maintained—to promote the secondary reactions named above, to reduce the necessary E.M.F. for a given current density, and to minimise the formation of perchlorates.

In closing his paper, Foerster stated that the ideal process for chlorate production should reach the efficiency attained in the electrolysis of a solution of pure calcium chloride, with which current efficiencies of 87 per cent. could be constantly maintained. It is possible that in time the efficiency obtained on an industrial scale will approach this figure. J. B. C. K.

1947. *Position of Industrial Electro-Chemistry.* **W. Borchers.** (Zeitschr Elektrochem. 6. pp. 61–80, July 20, 1899.)—This paper was prepared for the last annual meeting of the German Society of Electrochemists, in response to a request made by the Committee to Dr. Borchers at the meeting of 1898. It contains a statement of the power utilised and available at every electrochemical or electrometallurgical works now in existence, together with the names of the owners and of the engineers who supplied the plant and machinery; but as the information in Dr. Borchers' possession is incomplete, there are many gaps in the table in which this information is gathered together.

A diagram showing the extent to which electricity is used in the production of the more important metals or non-metals, and tables showing the estimated weight and value of this output, are also given in the original paper. The remaining portion of the paper discusses the current efficiency of the Hall and of the Heroult aluminium extraction processes, as revealed by the outputs of the works using these processes, and the possibilities of aluminium and of calcium carbide as energy carriers.

J. B. C. K.

1948. *Electrical Bleaching.* **V. Engelhardt.** (Elektrochem. Ztschr. 6. pp. 28–29, 1899; also Oesterr. Chemiker-Zeitung, Wien, 1898, 13.)—O. Prelinger, in the bleach-works of F. Gebauer in Charlottenburg, has obtained practical results on a large scale with a Kellner electrolytic cell attached to a tank, maintained at 20°–25° C. by a cooling worm (to prevent the formation of chlorates), and provided with a centrifugal pump and circulating pipes of hard lead. When 650 litres of sodium chloride solution of 10° Bé (110 kg. NaCl per cb. m.) were thus circulated for three hours with a current of 114 amp. and 112 volts (=19 H.P. hrs.) passing, the solution finally contained 0·85 per cent. active chlorine, or 5·5 kg. of active chlorine in the whole solution. Reckoning the price of salt at 96 kr. per 100 kg., and that of power at 1·41 fl. per 100 H.P. hrs., and taking the amortisation of the plant (at 10 per cent.) as 48 kr., the cost of the whole operation was 1·90 fl., which is equivalent to 36 kr. per kilogramme of chlorine. In a comparative experiment on 33,800 m. (2,800 kg.) of light cotton cloth, the electrolytic bleach (with 2·81 grm. of available chlorine per litre) and subsequent treatment with hydrochloric acid cost 2·52 fl., whilst a chloride of lime bleach cost 8·34 fl. In another experiment on the same scale the relative costs were 5·07 and 12·63 fl.

W. G. M.

1949. *Electrolytic Ozone.* **E. Andreoli.** (Électricien, 18. pp. 145–147, September 2, 1899.)—This article is a history of the early attempts to make ozone by the electrolysis of solutions, usually of an acid. Schoenbein is cited as the earliest worker in this field and the results he obtained are given. Soret in 1854 showed that the temperature of the solution had a marked effect on the amount of ozone formed, and his own and other figures are quoted, while the theories of Lupke, Le Blanc, Berthelot &c., are discussed. Finally, the author points out that Rhumkoff's coil has entirely superseded the electrolytic method, and that there is in fact no more recent patent for the latter than that of Donovan in 1860. The author asks whether the electrolytic method might not now be utilised in some special cases to advantage, considering the immense improvements that have been made in all the apparatus &c., for such work.

J. L. F. V.

1950. *High-Temperatures by means of Aluminium.* **H. Goldschmidt.** (Zeitschr. Elektrochem. 6. pp. 53–57, July 20, 1899.)—In this paper, read before the annual meeting of the German Electrochemical Society, the author reports upon the technical utilisation of his process for obtaining high temperatures by means of powdered aluminium. The details of this process

were described in a previous paper before the Society. The applications of the method are three :—

1. The production of metals and alloys. Manganese, chromium, various alloys of these two metals, ferro-titanium and ferro-boron are being produced at Essen by a company called the "Chemische Thermo-Industrie," and the industrial utilisation of the process is about to occur in France.

2. The production of artificial corrundum. This by-product of the reduction of metallic oxides by powdered aluminium is finding a ready sale for various purposes.

3. The production of heat for metal-working operations. The method is being used for hardening, for hard soldering, for welding, and other operations. The localisation of the heat is an important characteristic of the process. Its use for rail-bonding by welding on electric tram-lines, has been successfully initiated at Essen.

Defective parts in steel-castings can be made good by this method. J. B. C. K.

1951. *Magnetic Ore Separators.* **H. C. McNeill.** (Electrician 43. pp. 639–640, August 25th, and pp. 674–675, September 1, 1899. Abstract of paper read before the Iron and Steel Institute.) —A description is given of the following systems for the magnetic concentration of ores: Wenström, Monarch, Dellvik-Gröndal, Heberle, and Wetherill. W. R. C.

GENERAL ELECTRICAL ENGINEERING.

1952. *Iron-Consuming Batteries.* **J. Waterhouse.** (Soc. Chem. Ind. Journ. 18. pp. 559–560, June, 1899.)—An account of using iron instead of zinc in Daniell cells. No trouble occurred through deposits of basic iron. W. R. C.

1953. *Germain's Primary Battery.* (Écl. Électr. 19. pp. 422–424, June 17, 1899.)—This battery, which has come largely into use, is a form of Leclanché in which the electrolyte is retained between the plates by cellulose. Curves of discharge are given. W. R. C.

1954. *Aron Energy-meter with Automatic Rewinding.* **J. Reyval.** (Écl. Électr. 19. pp. 377–384, June 10, 1899.)—The chief defects of the old type of Aron meter were the necessity of periodical winding, of careful adjustment of the pendulums to synchronism in position, and the want of automatic starting of the pendulums. All these defects, with others, are removed in the new model, which has been accepted as accurate by the Austrian Government. The theory of the instrument is worked out [there is a misprint in a formula on page 379], and it is shown that in the old type the relative gain or loss of the pendulums was sensibly proportional to the energy consumed in the circuit. In the new pattern the pendulums are short, and vibrate so much faster than the long ones formerly used that a considerable error would be caused with the same method of control; this is eliminated by causing the current to act on both pendulums, so that while one gains the other loses with regard to the normal rate. The disturbing terms in the equations then vanish, while the error due to external magnetic fields is also minimised. The mechanism is described in detail, with numerous illustrations. As the synchronism of the short pendulums cannot be perfect, nor the magnetic reactions made identical in both cases, the resulting errors have to be neutralised by simultaneously reversing the direction of rotation of the clockwork and the current in the shunt coils, at intervals of about twenty minutes. The devices by which this is accomplished are minutely explained, as well as the self-winding mechanism, which consists of an electromagnet actuating a pawl and ratchet at intervals. There are two sets of differential gear, one for the driving and the other for the integrating device. The method of connecting the meter with the circuit is also described. Additional advantages claimed for this meter are permanence of standardisation, as there are no steel magnets; freedom from thermal, frictional, and magnetic

errors; starting on very small loads; low consumption of power (1·8 watts in a 1,000 watt meter); and accuracy of records with alternating as well as direct current, no matter what the frequency or phase difference. A. H. A.

1955. *Long-Schattner Supply Meter.* (Electrician, 43. pp. 155–156, 1899.) (See 1899, Abstract No. 603.)—The amount of copper deposited is measured by a weight which slides on a beam graduated in watt hours for any prearranged voltage of supply. Drop of volts on 100-volt meter is 0·7 at full load, viz., 10 amperes. A $CuSO_4$ solution of 1·080 specific gravity is employed, *i.e.*, with 1 per cent. sulphuric acid and 99 per cent. water. Accuracy within 2 per cent. at 1 to 10 amperes and 4 per cent. at 0·15 ampere. M. O'G.

1956. *Lightning and Lightning Arresters.* **H. E. Raymond.** (Amer. Electn. 11. pp. 214–215 and 262–263, June, 1899.)—Leyden jar experiments seem to show that (1) the lower the voltage the smaller the effect of resistance upon the discharge; (2) the greater the capacity the less is the discharge affected by resistance; (3) the shorter the resistance for a given cross section the less its influence; (4) the discharge will be affected by any reactance to quite a considerable extent.

In the action of arresters on the line we note, first, that the discharge is opposed by considerable length of resistance, and but little by amount of resistance in ohms in shorter lengths; second, that the length of gap determines the striking-point of the arrester; third, that the inductance of the line introduces a favourable factor; fourth, that the capacity of the discharges affects the striking-point, in that for a given distance the greater the capacity the lower the striking tension; fifth, that reactance coils offer but little impedance to lightning discharges, and a considerable opposition to Leyden jar sparks; sixth, that the voltage of line discharge is much less than that of the Leyden jar, with a long gap in series with its circuit.

Considering the line as a condenser alternately charged by the atmospheric disturbances and discharging to earth at certain conditions of electrostatic unbalancing or dielectric strain, there are the following differences between this condenser and its action and the Leyden condensers and their action: the line is presumably of higher capacity, and certainly of greater self-induction; the lightning discharges are of much lower frequency, as is shown by the slight effect of a reactance coil upon them. These points explain the fact that an arrester with a short gap and a moderate resistance in series will take a line discharge in preference to one without resistance and with a longer gap. [See Abstracts Nos. 1387, 1389 (1898), and No. 605 (1899).] W. G. R.

1957. *Lightning Arresters.* **Bochet.** (Soc. Int. Elect. Bull. 16. pp. 184–207, 1899.)—This paper gives an illustrated description of various lightning arresters for the protection of electric lines, and contains also a discussion of the conditions which arresters should satisfy. W. G. R.

1958. *Fuse-wires for Air-lines.* **J. Mattausch.** (Zeitschr. Elektrotechn. Wien, 17. pp. 159–160, 1899.)—In localities where danger is likely to occur to aerial lines, owing to stray currents from other circuits or to lightning, it is proposed to introduce fuses into every span of wire. The fuses are arranged so that the line-wires exert no strain upon the fuse-wire; and when a fuse "blows," the line-wires are still upheld. To get this result an insulating shackle is introduced into each span to take the strain, and fuse-wire is used to establish electrical connection between the ends of the shackle. Various modifications are described. R. A.

1959. *Concentric Wiring.* **M. O'Gorman.** (Elect. World and Engineer, 34. pp. 228–231, August 12, 1899.)—A defence of this system is given—it does not affect telegraphs or the ship's compass. Leakage current, shocks, or fires are impossible; the quantity of copper and rubber in cables is diminished; lamps can be screwed into the same sockets as fittings if the latter break down. Concentric flexibles are smooth externally, and being at zero potential attract no dust. Switchboards are waterproof and cheap because single pole. A special method of testing cables is given. E. H. C.-H.

1960. *Electricity in Coal-Mines.* **H. N. Gardner.** (Amer. Electn. 11. pp. 373–375, August, 1899.)—This article deals chiefly with the various conditions to be met in designing electrical machinery for mining work, the chief of which are rough usage and dirt; some practical notes on the methods adopted are given. A. H. A.

1961. *Electrically Driven Workshop of the A. E. G.* (Electrician, 43. pp. 437–440, July 21, 1899.)—Up to 2·000 H.P. is absorbed by the three-phase electric plant of the Allgemeine Elektricitäts-Gesellschaft. The astonishing development of this factory is traced, and the electrically driven lathes and tools illustrated. A plan and elevation of the works is given. M. O'G.

1962. *Modern Workshop Practice.* **F. Bathurst.** (Elect. Rev. 45. pp. 275–279, August 18th, and pp. 299–303, August 25, 1899.)—A detailed description, with numerous illustrations, of the machine tools and methods in use in the workshops of E. Kolben and Co. A. H. A.

1963. *Electrical Machinery on Board Ship.* **A. Siemens.** (Electrician, 43. p. 815, September 29, 1899. Paper read before the British Association, 1899.)—The chief advantage of electric power on shipboard is the absence of clumsy and leaky pipes. The difficulty is the variations in the loads on auxiliary machinery. The strain on a winch often stops it. In such cases, shunt-wound motors driving through friction clutches are used, or else series-wound motors with a special cut-out arranged to break the main circuit on occasion and only allow a certain current to flow through a by-pass circuit. The author mentions an electric steering gear and rudder indicator as an example of the first method. E. H. C.-H.

1964. *Automatic Pressure Regulator.* (Electrician, 43. p. 573, August 11, 1899.)—The "Chapman" regulator for automatically varying the resistance in the shunt circuit of dynamos is described and illustrated. There are two solenoids, one of which is subjected to the potential difference to be regulated, and controls the other; the latter actuates a multiple-point resistance switch in series with the exciting circuit. The instrument can be compounded to give a rising pressure with increase of load, and can be applied to alternators as well as dynamos. A. H. A.

1965. *Thawing Water-Pipes with Electricity.* (Canad. Elect. News, 9. pp. 57–58, 1899.)—Frozen water service pipes are thawed by means of alternating currents passed through the pipes themselves. A pressure of 20 to 50 volts is used, obtained from a portable transformer connected with the street mains; a current of 200 to 400 amperes is passed through the frozen pipe until the water flows freely, which usually takes place in a few minutes. Details of actual cases are given. A. H. A.

1966. *Electric Engraving Machine.* **F. J. Patten.** (Elect. World and Engineer, 34. pp. 306–307, August 26, 1899.)—The electric pantograph described in Abstract No. 1824 (1899) is here applied to the process of engraving upon wood or metal. Instead of merely tracing the picture as in the pantograph, the stylus is arranged to cut or engrave the lines to any desired depth. R. A.

1967. *Wool Removed from Skins Electrically.* (Electrician, 43. p. 333, June 30, 1899.)—This is a description of an electrical knife made of a platinum iridium wire rendered incandescent by a current of about 60 amperes at 4 volts. W. G. R.

1968. *Portable Electric Drilling Machine.* (Elect. World and Engineer, 34. p. 105, July 15, 1899.)—This is a description of a drill driven by an electric motor with a 50 per cent. speed regulation, and manufactured by the Stow Company, of Binghamton, N.Y. W. G. R.

1969. *Electric Power in Steel-Making.* **E. B. Clark.** (Cassier, 15. pp. 441–455, 1899.)—A paper written in popular style, giving an account of the application of electric power to machines used in steel-making, *e.g.*, charging and drawing machines, gantry cranes, locomotive cranes, drills, punches, shears, and electromagnets for handling plates. The paper is accompanied by numerous photographic illustrations. A. S.

1970. *Installation of Steam Boilers.* (Elect. Rev. 44. pp. 973, 1010–1012, 1056–1057, 45. pp. 124–126, 177–178, 376–377, 426–428, 505–506, 735–736, 1899.)—An illustrated series of articles on the construction and erection of steam boilers.

EDITOR.

1971. *Simple Steam Engine with Remarkable Economy.* (Amer. Electn. 11. p. 208, 1899.)—The steam engine designed by Elihu Thompson for steam automobile work has four cylinders each $2\frac{1}{2}$ in. diameter and 3 in. stroke, all single acting and worked single expansion, the output of the four being about 5 H.P. The economy obtained with this small engine reached $20\frac{1}{2}$ lbs. of water per H.P. hour, the steam pressure being between 160 and 200 lbs. with a considerable degree of superheating, the engine at times being worked with the steam-pipe red-hot. The steam is admitted to the cylinder by a simple poppet-valve, and expands until the piston uncovers the exhaust ports. The conditions are such that there is no retraversing of any of the passages by the steam. The steam is always moving in one direction, so that there are no inter-actions to cause waste of energy. A. S.

1972. *Electric Light and Traction Engines.* (Elect. Rev. 44. pp. 980–982, June 16th; 1069–1070, June 30th; 45. p. 24, July 7, 1899.)—A series of articles on the general design of steam engines for electric light and traction power stations.

EDITOR.

GENERATORS, MOTORS, AND TRANSFORMERS.

1973. *Over-Compounding Dynamos.* **E. K. Scott.** (Elect. Rev. 45. pp. 428–429, September 15, 1899.)—The author describes a method of compensating for the curvature of the B–H curve by shunting the series coils with iron wire; as the load increases the resistance of the iron increases with rise of temperature more rapidly than that of the copper coils, thereby shunting a smaller proportion of the total current. It is remarked that over-compounding, by increasing the magnetic flux, tends to reduce sparking at the brushes. The common practice of specifying that dynamos for electricity works shall be designed for 460 volts for lighting, but shall be able to work at 550 volts for traction, is criticised on the score that the weak field in the former case conduces to sparking and involves increased first cost.

A. H. A.

1974. *Regulation of Alternating Current Generators.* **C. L. Cory.** (Journal of Electricity, 8. pp. 33–40, August, 1899. Paper read before the Pacific Coast Electric Transmission Association, San Francisco, June 20–21, 1899.)—The chief item affecting the regulation of alternators is the power factor of its load, since a load of low power factor means large wattless demagnetising current in the armature of the machine. W. G. R.

1975. *Crocker-Wheeler Motors for Special Purposes.* (Elect. World and Engineer, 34. pp. 140–141, July 22, 1899.)—The paper describes, among others, a motor specially designed for driving machinery which has to be stopped with precision. One pole-piece is hinged and forced away from the armature by a strong spring which at the same time tightens a band brake on a brake drum attached to the armature spider. When the field is excited the movable pole-piece is pulled toward the armature and the band brake released. The spring and brake band may be adjusted so that the armature is stopped and held firmly the instant the current is cut off, or it may be allowed to make a few revolutions before stopping. R. B. R.

1976. *Theory of Induction Motors.* **J. Heubach.** (Elektrotechn. Ztschr. 20. pp. 301–305 and 314–317, 1899.)—The first part of the paper is devoted to polyphase motors. Considering the field of the stator, the author remarks that the intensity of the field undergoes, in general, fluctuations consequent on the fluctuations in the inducing ampere-turns. He considers the two

extreme cases in which the ampere-turns have (*a*) a maximum and (*b*) a minimum value, and draws diagrams (consisting of zigzag lines) illustrating roughly the distribution of the field in these two cases for a two-phase and a three-phase motor in which each side of a stator coil is distributed over three tunnels in the stator core. Next comes the calculation of the counter E.M.F. in the stator: this is determined by supposing the stator coils displaced, step by step, in a stationary field which resembles the rotating field of the motor, calculating the instantaneous values of the E.M.F. corresponding to each small displacement until a complete half-wave has been traced out, and then finding its R.M.S. value. The actual rotating field, is, however, a pulsating one; in applying the method just described for finding the E.M.F., the author overcomes the difficulty by considering the two cases (*a*) and (*b*) separately, and supposing that in each case the rotating field remains constant. The result of this investigation shows that the R.M.S. value of the E.M.F. is the *same* in each case, notwithstanding the fact that in case (*a*) the maximum field-intensity is higher. From this it follows that the total flux from a pole is not a constant quantity. The torque is next calculated on the supposition that the actual field of the motor is replaced by an equivalent sine field. The calculation of the torque involves the introduction of certain constants depending on the rotor winding and the breadth of its coils. The results obtained are applied to Heyland's diagram for the induction motor (Elektrotechn. Ztschr. 1896). The second part of the paper deals with the single-phase motor. The results obtained for polyphase motors may be applied to the single-phase motor by supposing the latter replaced by two equal and mechanically coupled polyphase motors whose inducing windings are connected in series in such a manner as to produce oppositely rotating fields. By this artifice the diagram of the single-phase motor may be deduced from the corresponding two diagrams of the equivalent pair of polyphase motors. The calculation of the primary field, primary counter-E.M.F., and of the torque, proceeds on the same lines as those already indicated for the polyphase motor. The paper contains valuable tables of the coefficients for different kinds of windings which are required in motor calculations, and the practical value of which has been tested by the author.

A. H.

POWER DISTRIBUTION, TRACTION, AND LIGHTING.

1977. *The Feeder System at Boston, U.S.A.* (Railway World, 8. pp. 237–244, July, 1899.)—The mileage operated is over 300 miles of single track, and the cables used comprise 510 miles of feeders and 70 miles of insulated return wires. The sections of copper were calculated from the following formula :—

$$S = \frac{1{\cdot}5\ PAMG^2}{V^2\ (G - 1)}$$

where—

S = cross section of feeder in circular mils.
P = power delivered to cars in watts, nominal.
A = specific resistance of copper per mile-mil.
M = distance to centre of load, miles.
V = pressure at power station in volts.
1·5 = a constant representing the ratio between total drop and feeder drop.
G = economical constant which may have any value between 1 and 2 and is determined by one of the following formulæ :—

For overhead lines—

$$G = 1 + \sqrt{\frac{2{\cdot}25\ M^2A\ (CD + E_oF_o)}{2{\cdot}25\ M^2A\ (CD + E_oF_o) + V^2\ (H\ I\ 8760 + JK)}}$$ or

For underground lines—

$$G = 1 + \sqrt{\frac{2{\cdot}25\ M^2A\ (CD + E_uF_u)}{2{\cdot}25\ M^2A\ (CD + E_uF_u) + V^2\ (H\ I\ 8760 + JK)}}$$

where—

C = cost of copper in dollars per mile-mil (copper only, and does not include cost of insulation and installing).
D = interest and depreciation on above amount.
E_o = cost of insulating and installing copper overhead per mile-mil.
E_u = cost of insulating and installing copper underground per mile-mil.
F_o = interest and depreciation on above amount for overhead lines.
F_u = interest and depreciation on above amount for underground lines.
H = time factor of energy lost in feeder.
I = cost of producing this energy per watt hour.

J = cost of generating plant per watt installed.
K = interest and depreciation on plant.

The average insulation resistance of the underground cable ranges from 200 to 1,500 megs. per mile. E. H. C.-H.

1978. *Electricity Works of Small Output.* **A. D. Adams.** (Amer. Electn. 11. pp. 263–264, June, 1899.)—The author discusses the problem of electric lighting for comparatively small towns generating their own electrical energy, and gives a comparison of the direct and alternating systems for such a purpose. W. G. R.

1979. *Plymouth Electricity Works.* (Elect. Engin. 24. pp. 102–110, July 28th, and pp. 146–149, August 4, 1899.)—These articles contain a full illustrated description of the Plymouth combined lighting and traction works. The lighting plant is 2,000 volts alternating and the traction plant 500 volts continuous current. One engine carries a dynamo and an alternator on the same shaft in order to deal economically with light loads. The coal arrangements are very complete, and the whole cargo of a 600-ton ship can be discharged in two days. Lancashire boilers without cross-tubes are used, worked at 130 lb. pressure, but constructed for 160 lb. to avoid reduction in working pressure as the boilers age. Instead of being individually lagged, a non-conducting floor has been formed over the battery of boilers. The motors of the electric 3-throw pumps are arranged with two totally distinct circuits to their armatures, so that they can be economically run at 730 r.p.m. when the two circuits are in parallel, or at 365 r.p.m. when in series. The feed and steam pipe arrangements have received particular attention. A ring steam main has been avoided. E. H. C.-H.

1980. *Potteries Electric Tramways.* (Railway World, 8. pp. 203–212, June, 1899.)—This system will comprise 35 miles of tramway on a 4-feet gauge. Current at 500 volts will be supplied to the whole system from two stations. The drop in the return circuit will be kept down by negative boosters. A full description is given of the power station at Stoke-on-Trent.
E. H. C.-H.

1981. *Bommern-Witten Tramway.* **M. Schiemann.** (Elektrotechn. Ztschr. 20. pp. 507–510, July 20, 1899.)—This is an illustrated description (9 figures) of a typical German electric tramway which has been equipped by the firm of O. L. Kummer

and Co. of Dresden. The power station has steam-driven sets—150 lbs. steam, 135 revs. per minute, eight-pole dynamos—and there is also a buffer battery of accumulators. Three very clear diagrams of connections are given. The first shows the series parallel and brake connections of the motors at various points of the controller; the second is a car-wiring diagram; and the third gives the switchboard diagram arranged for four dynamos, the battery, and ten feeder circuits.

The station arrester described is a modified form of the Thomson circuit breaker, the curved horns of the latter being replaced by two carbon blocks — one adjustable — which are held on the ends of two steel cores which pass down the interior of the blow-out coil. E. K. S.

1982. *Electric Traction.* **A. D. Greatorex.** (Electrician, 43. pp. 627–629, August 25th; 676–677, September 1st; and 702–704, September 8, 1899.)—Abstract of a paper read before the Incorporated Association of Municipal Engineers, giving a brief description of the various systems of traction—overhead, conduit, accumulator, and combined—with estimates of their cost. E. H. C.-H.

1983. *Electric Traction Statistics as Data for Design.* **A. Hecker.** (Elektrotechn. Ztschr. 20. pp. 590–592, August 17, 1899.)—The author, after carefully investigating available statistics, finds that if abnormal cases be excepted, there are definite relations connecting the number of inhabitants with the gross receipts and the number of car-miles run. These relations may be expressed by the following formulæ:—

$$y_1 = 2{\cdot}5 \times 1{\cdot}12^{\frac{x_1}{4} - 1}$$

where y_1 denotes the receipts per head per year, in shillings, and x_1 the number of inhabitants divided by 10,000. Further—

$$y_2 = 10 \times 1{\cdot}08^{\frac{x_1}{4} - 1}$$

y_2 denoting the number of car-miles per year per inhabitant. A. H.

1984. *Controlling Stray Currents on Electric Railroads.* (Elektrotechn. Ztschr. 20. pp. 427–429, June 15, 1899.)—This is the discussion on a paper read by **M. Kallmann** before the Elektrotechn. Verein, Berlin (see 1899, Abstract No. 1301). **Wagner** pointed out the very small loss in weight (100 grms.

and 205 grms.) of the two earth plates in the generating station at Spandau after 2½ years' running. **West** described a method of determining the resistance of rail joints by a Wheatstone Bridge test between three equidistant insulated axles of a special truck. **Kallmann** discussed the effect of joints on rail resistance, and described a laboratory experiment illustrating leakage currents, the methods of testing, and the effect of distance between feeding-points. **Glaisberg** pointed out that the electrolytic corrosion by stray currents depends on the absolute value of such currents and the distance between the feeding-points, which should therefore be made the basis of the regulations with regard to leakage, instead of the percentage leakage as specified by the English Board of Trade. L. B.

1985. *Indispensable Accessories of Electric Traction.* **H. E. P. Cottrell.** (Elect. Rev. 44. pp. 667–670, 711–713, and pp. 755–758, 1899.)—These, the first three of twelve fully illustrated articles on the above subject, deal with trucks. (pp. 843–846, 923–925, June 9, and 1051–1053, June 30, 1899): Brakes. (45. pp. 88–91, July 21, 1899): Roller bearings, life-guards, gongs, track-scrapers, sand-boxes, heaters. (pp. 211–214, August 4, 1899): Heaters and lighting. (pp. 260–262, August 18, 1899): Lighting couplings, commutator segments, brushes, circuit breakers, lightning arresters. (pp. 303–305, August 25, 1899): Trolleys, couplings. (pp. 349–351, September 1, 386–387, September 8, and 424–426, September 15, 1899): Bonding and welding. E. H. C.-H.

1986. *Overhead Line Material for Electric Railways.* **Benz.** (Elektrotechn. Ztschr. 20. pp. 493–498, July 13, 1899.)—A detailed description of trolley wire insulators, strain insulators, cross-wire suspension insulators, pull-over brackets, frogs, joints, &c., as made by the Allgemeine Elektricitäts-Gesellschaft of Berlin. Stabilit, a vulcanised fibre material, is used for the insulation, and the author gives its resistance after being kept in a damp atmosphere for four weeks at 8·5 megohms per cubic centimetre.

The article is illustrated by 48 figures, of which ten are line drawings in section. E. K. S.

1987. *Overhead Line Construction.* **A. B. Herrick.** (Street Rly. Journ. 15. pp. 277–281, 437–440, July, 513–515, August, 1899.)—Articles descriptive of the construction in detail of overhead trolley lines, including the proportioning of feeders.

EDITOR.

1988. *Rail-Bonding.* **R. D. Appleton.** (Railway World, 8. pp. 269–270, July, 1899. Paper read before the Railway and Electrical Association of Virginia, U.S.A.)—Bonds of solid copper become loose owing to expansion. Flexible bonds break off. Electric welding decarbonises the ends of the rails and results in two thumps per joint instead of the usual one. Cast welds are good mechanically, but their resistance is high, and gets higher with time. The ideal bond must absolutely prevent corrosion of contact surfaces by excluding water in spite of all variations of temperature. It must be able to give and take as much as an eighth of an inch per joint again and again without breaking or crystallising. It should be capable of carrying as much current as the rail itself. The author has in three years' experience found these qualities in the plastic bond. E. H. C.-H.

1989. *Electric Rail Welding.* (Elect. World and Engineer, 34. pp. 234–235, August 12, 1899.)—This is a short description of the electric rail welding plant of the Lorain Steel Company, Ohio, as employed in making 7,500 rail joints in the Buffalo street railway system. The trolley wire current is transformed by a rotary converter carried on the car into single-phase current of 300 volts, and then down to 5 or 7 volts by a static transformer of one secondary turn giving up to 25,000 amps. The joint is made by means of fishplates welded on to either side of the web under heavy pressure. Each joint takes fifteen minutes to complete. L. B.

1990. *Brake Shoes.* (Street Rly. Rev. 9. pp. 477–480, July, 1899.)—This paper gives an account of patents on brake shoes for the last thirty years, of tests prior to 1895, and a summary of the most recent experiments. A table showing the mean coefficients of friction is given, having been prepared from the data published in the Master Car Builders' Proceedings, from the Reports of Tests made for the Sargent Company, Chicago, and from the Reports of Tests by Goss of Purdue University. The tests were made at initial speeds of 65, 40, and 30 miles per hour respectively; and two diagrams are given showing the mean coefficient of friction, and the distance run before stopping on the assumption that each shoe has to absorb the energy of a mass of 12,000 lbs. As a rule, the coefficient of friction is less at the high speeds; the total variation over the experiments recorded being from 11 to 39 per cent. The effects of the various brake shoes on a chilled wheel and on a steel-tired wheel are recorded. A. S.

1991. *Thermal Tests for Car Wheels.* (Street Rly. Rev. 9. pp. 486–487, July, 1899.)—Goss and Smart of Purdue University

have made some experiments for the Griffin Wheel Company, of Chicago, on thermal tests of wheels, and the heating to which a car wheel will be subjected in service. The wheel specifications of the Pennsylvania Railroad Company provide for a thermal test by pouring a ring of cast iron 1½ inches by 4 inches in section around the tread of the wheel, the pouring being made from one point on the circumference, and the ring being removed two minutes after pouring. In the tests made at Purdue a soft cast iron brake shoe was applied with a pressure of 2,800 lb., and the wheel driven for twenty minutes at a peripheral speed of 30 miles an hour. At the end of the test an examination showed that sulphur, which had previously been inserted in a hole 3 inches from the tread, had melted (240° F.), while no part of the wheel more than 2 inches from the tread was hot enough to melt tin (440° F.). A second wheel was run for five minutes at 50 miles an hour with a brake pressure of nearly 3,000 lb. At the end of the five minutes the conditions were so severe as to threaten the destruction of the shoe, and the test was stopped. Sulphur was not melted at a distance greater than 2 inches from the tread. The Pennsylvania thermal test was applied to similar wheels, and the results showed that the rise in temperature was most rapid in that side next to the pouring, and slowest at a point diametrically opposite.

A third series of tests were made in which the channel provided for the molten iron had different dimensions from those called for in the Pennsylvania specifications, the molten iron being poured into the mould from two points diametrically opposite. The maximum temperature of a point 3 inches from the tread was 440° F., and the time required to reach a temperature of 240° F. was 5·75 times as great as in the brake test. From these tests the conclusion is drawn that the Pennsylvania thermal test is much too severe, and the modification of the specifications as in the third series of the Purdue tests would amply provide for safety. A. S.

1992. *Diatto Surface Contact System.* **J. Blondin.** (Écl. Electr. 19. pp. 121–130, 1899.)—About 2 km. of line at Tours are equipped with Diatto's electromagnetic system. Under each contact-plate is a box containing a magnetic plunger, the top of which makes (carbon) contact with the surface-plate when drawn up, while the lower end travels in a mercury cup connected to the feeder. The car carries electromagnets specially arranged. An alarm contact behind the car rings a bell if a section remains alive. E. H. C-H.

1993. *W. R. Smith's Overhead Conduit System.* (Railway World, 8. pp. 266–268, July, 1899.)—The conduit is a small tube of papier maché, suspended horizontally 22 feet above

the street by $\frac{1}{16}$ inch steel wires hung from a 1 inch wire rope supported on poles 100 yards apart. Current is taken from two copper rails supported on insulators within the conduit. A small truck with four flanged wheels runs on the rails within the conduit, being kept in contact by a roller and spring. This truck is drawn along by conductor cords, which are reeved over a pair of tackle falls on the car to pay out and in at a uniform tension, to allow for the lateral movement of flangeless wheeled vehicles on ordinary roads. At points a short length of the conduit before the branch is hinged and is swung from one line to the other by the motor man pressing a button in the circuit of one of two electromagnets. The claims for this system are: (1) It costs 48 per cent. less than the trolley system to convert an existing tramway from horse haulage to electric traction. (2) It costs 10 per cent. less than the trolley system to lay a new line. (3) Freedom from all electrolysis. (4) There is no wear upon the supporting wires, and no lateral strain upon the supporting pillars. (5) Tramway rails may be dispensed with where the traffic is light or the rails inconvenient. (6) The points and crossings of the conduit are on one level. E. H. C.-H.

1994. *Combined Electric and Petrol Motor Car.* **É. Hospitalier.** (Ind. Élect. 8. pp. 316–319, July 25, 1899.)—The Pieper Company have brought out a car which is normally propelled solely by an oil engine, but on hilly ground is helped by an electric motor. The oil engine works at a constant rate, and when the vehicle does not absorb all the engine's power the excess drives the motor as a dynamo and charges the accumulators. As the accumulators only have to supply power occasionally, they are kept fully charged, and can therefore (as was clearly shown at the French Automobile Club cell trials) safely give rates of discharge which would seriously damage them if the cells were only partially charged. The engine having always to work at constant speed and load, a simple carburetter is used, adjusted once for all. The engine is direct coupled to the dynamo-motor, which is shunt wound, and is used to start up the engine. The rate of charging can be adjusted by field-regulation. Changes of speed are effected mechanically. The engine gives 2,500 watts, and the motor about 1,800, so that on hills nearly 5,000 watts can be obtained. The battery of 40 cells weighs 125 kg. complete, and can give up to 20 watts per kg. of total weight. Backward motion is obtained by shutting off the carburetted air from the engine and reversing the current in the armature of the motor. The three-passenger vehicle complete, without live weight, weighs 600 kg., and runs up to 30 km. per hour. It will take 12 per cent. grades at 12 km. per hour. The author predicts that the "petro-accumobile" will be the cab of the future. E. H. C.-H.

TELEGRAPHY AND TELEPHONY.

1995. *Mercadier's Multiplex Telegraphy.* (Elektrotechn. Ztschr. 20. pp. 305–307, 318–320, and 336–337, 1899.)—This system was described in the Annales Télégraphiques in 1891. It consists in "tuning" a set of telephones so that each responds to an alternate current of one, and only one, periodicity. These so-called "monotelephones" may be connected in series, one at each station, and any particular station can be signalled to by an alternating current of the appropriate periodicity. The present articles describe the arrangement of circuits and apparatus, and the author gives his reasons for believing that this system is more economical than those which have preceded it. R. A.

1996. *Wireless Telegraphy.* **J. J. Green.** (Amer. Electn. 11. pp. 344–346, July, 1899.)—Elementary description with photographs of apparatus. A failure to communicate across Chicago is ascribed to the direct line between the tops of the vertical wires being intercepted by telegraph wires. M. O'G.

1997. *Selector System of Circuits.* **E. Bernard.** (Elect. Rev. N.Y. 34. pp. 225–227, 1899.)—This is a translation in English of the article by J. Voisenat on the Bandot system of telegraphy. (See 1898, Abstract No. 1300.) R. A.

1998. *Telephone Exchanges.* **B. von Wehrenalp.** (Zeitschr. Elektrotechn, Wien. 17. pp. 331–340, June 14, 1899.)—A detailed description, with coloured charts, of the new system of telephone exchanges at Vienna. R. A.

1999. *Private Central Telephone Stations.* **Mandroux.** (Électricien, 15. pp. 122–125, 1898.)—Diagrams explaining "Monocord" systems as used by the French Government. (See 1898, Abstracts Nos. 462 and 463.) M. O'G.

2000. *Transmitter Working with 20 Volts.* **G. Dumont.** (Électricien, 17. pp. 305–308, 1899.)—By using a special granular material, in a modified box with receivers having an extended magnetic field, 20 volts can be used without producing harsh sounds, and with increased clearness on long lines. M. O'G.

NAME INDEX.

[*Names not followed by Titles are not Authors, but only names mentioned in Abstracts. The numbers refer to Abstracts.*]

Abbe, 3, 243, 1137
Abbot, 480
Abbott, A. H., colour, 788
Abbott, A. V., electrical radiation, 1829; electrolysis from railway currents, 1810
Abegg, 143
Abegg, R., dielectric properties of ice, 74; electrolytic conductivity, 1233
Abraham, 585, 1755, 1756
Abraham, H., break-up of a discharge, 1495
Abraham, H., & J. Lemoine, Kerr phenomenon, 1859
Abraham, M., electric oscillations, 285; phase of Hertzian oscillations, 819
Abt, A., magnetic properties of hematite, 1924; magnets, 833
Adams, A. D., arc lamp, 1307; dynamo and motor capacities, 1274; electricity works of small output, 1978
Adeney, W. E., & J. Carson, Rowland grating, 247
Agamennone, 1634
Agamennone, G., earthquake in Hayti, 416; earthquakes in Labuan, 415
Agostini, B., electromagnetic waves and selenium, 291
Airy, 71, 423, 1656
Albrecht, 1645
Aldridge, J. D. W., electrical plant for docks and harbours, 513
Alexander, H., decomposition of sulphur, 332
Aliamet, Cauderay multiple electric meter, 897 : rotary converters, 1280
Aliamet, M., Vulcain meter, 1419
Aliamet, M., & E. J. Brunswick, permeameter, 114
Aliamet & E. Sartiaux, Leblanc rectifiers, 1583
Alioth, 1071
Allen, A. H., canal haulage, 616
Almansi, E., elasticity of a pendulum, 1460
Almy J., spark discharge in dielectrics, 1378
Alteneck, Hefner-, 16
Amagat, 43, 721, 807, 1006, 1209, 1493, 1689, 1874
Amagat, E. H., characteristic equation for fluids, 1007; pressure, volume, and temperature in fluids, 1877; saturated vapours, 674
Ampère, 66, 299
Anders, 972
Andrée, 1704
Andreoli, 873, 1755
Andreoli, E., deposition of gold, 875; electrolytic ozone, 1949; electrometallurgy, 1410; restoration of photographic plates, 1335; sterilising water by ozone, 1756
Andrews, 665
Andriessen, H., utilising capacity of cables, 900
Ångström, 39
Ångström, K., thermal radiation, 671
Anthony, C. C., railroad signalling, 1253
Anthony, W. A., polarisation, 700
Applegarth, 873
Appleton, J., applications of accumulators, 947, 1436
Appleton, R. D., rail-bonding, 1988
Appleyard, R., copper temperature-coefficient, 1505
Appunn, A., 810, 1885; difference tones, 446; vibrations of pipes, 445
Apt, R., & H. W. Hoffmann, incandescent lamps, 99
Archibald, E. H., and J. G. MacGregor, conductivity of double salts, 595
Aret, 1242
Argand, 1475
Armagnat, 1518; Blondel-Carpentier hysteresis tester, 710
Armagnat, H., meters, 168, 1421; Wehnelt interrupter, 1519

Armanini, E., electric density on a conductor, 69
Armstrong, A. H., electric traction, 367
Arno, 1027
Arno, R., electrostatic wattmeter, 115
Arnold, 204, 1264
Arnold, B. J., central station design, 948; traction, 1436
Arnold, E., commutator, 1266
Arnold, E., & G. Mie, theory of commutation, 1084
Arnot, W., cost of electricity, 950
Aron, 1421, 1954
Arons, 689, 1470
Arons, L., string interrupter, 313
Arrhenius, S., reaction velocity, 1202
d'Arsonval, 92, action of gases on caoutchouc, 1739; contact breaker, 585
Arth, G., electrolytic analysis, 870, 1751
Aschkinass, 690
Aschkinass, E., coherers, 292; Neugschwender's wave detector, 820
Aschkinass, E., & H. Rubens, heat-waves, 553; infra-red absorption, 21
Ashcroft, 598, 1757
Aston, 731
Atkins, 873
Atwood, G. F., direct-reading engine-power gauge, 494
van Aubel, E., magnetism and gas spectra, 428; thermal-conductivity, 1146
Auer, 1475
Auerbach, F., & A. Meyer, contact resistance, 297
Austen, Roberts-, W. C., 49, 848, surfusion of metals and alloys, 46
Avery, 1751
Avogadro, 541
Ayres, C. H., & E. H. Hall, conductivity of cast-iron, 1357
Ayrton, Mrs., electric arc, 304
Ayrton, W. E., mining, 921
Ayrton, W. E., & J. V. Jones, ampere balance, 1186
Ayrton, W. E., & T. Mather, galvanometers, 703

Baccei, P., spectra of gases, 1346; spectra of gaseous mixtures, 1483
Bagard, H., electrolytes in a magnetic field, 469
Bagot, J. C., ship-wiring, 532
Bailey, F. G., wiring rules, 748
Baillard, E. V., Murphy system, 1443
Bain, 873
Baker, T. J., & T. J. Baker, Jr., electro-deposition of brass, 1748
Bakker, G., capillarity, 1320; theory of liquids (part ii.), 59
Bakkuis-Roozeboom, 854, 1220; solidification, 1221; solubility and melting-point, 1210, 1402
Ball, 1591
Bamberg, 737
Bancroft, C. F., automatic block system 1444
Bancroft, W. D., dissociation studies I., 1222; pressure-temperature diagrams, 855; stereoisomers, III., 1219; ternary mixtures, 1403; transference value of hydrogen, 481; voltaic cell 482
Barber, C. M., power in workshops 1281
Barbier, 1596
Barbillion, L., dielectric-constants 1713; dispersion: luminous and electric, 1674
Barmwater, F., mixed electrolytes 1232; osmotic pressure, 1224
Barnard, 655; electricity works, 1798
Barnes, H. T., sulphur, 1208
Barnes, H. T., & A. P. Scott, solution densities, 398
Barnes, H. T., & H. L. Callendar specific heat of water, 1879
Barstow, W. S., Brooklyn electric supply system, 1796
Barton, E. H., 1168, electric waves, 2844 oscillatory discharge, 1161
Barton, E. H., & W. B. Morton, oscillatory discharge, 1379
Barus, 1741
Barus, C., aqueous fusion of glass 1045; ballistic galvanometry, 1133 colloidal glass, 1043; compressibility of colloids, 982; harmonic motion 1117; hydrated glass, 1044; inertia 654
Bary, P., meters, 635; Wehnelt interrupter, 1517
Basquin, O. H., & H. Crew, source of luminosity, 543
Bassot, measurement of an arc of the meridian, 1636; modern geodesy 1124
de Bast, alternate current circuits, 1733
de Bast, O., & E. Gerard, enclosed arc lamp, 1605
Bastian, 1421
Bastians, 889
Bathurst, F., wiring rules, 748; workshop practice, 1962
Battelli, A., & A. Stefanini, freezing and boiling-points, 1055
Battelli, A., & M. Pandolfi, water optically uniform, 1653
Battelli, F., & J. L. Prevost, physiological action of alternating current 651
Baum, F. G., instrument-reading, 1114 transformer diagram, 1191
de la Baume-Pluvinel, A., solar spectrum, 989
Baxter, W., Jr., induction motors, 1088

Beadle, A. A., iron-consuming batteries, 1413
Beattie, J. C., leakage from charged bodies, 1376
Beaulard, 656
Beaulard, F., polarisation of dielectrics, 1908
Beaumont, 1421
Beckenkamp, J., crystalline polarisation, 657
Becker, 738
Becker, H., diaphragms for electrolysis, 737 ; electrolytic vats, 873, 1242
Becquerel, 545, 1140, 1142, 1478, 1672
Becquerel, H., anomalous dispersion and magnetic rotatory power, 426 ; anomalous dispersion of sodium vapour, 999 ; magnetic rotatory polarisation, 246 ; radio-active bodies, 1002 ; vapours in magnetic field, 427
Becquerel, H., & H. Deslandres, Zeeman phenomenon, 32, 33
Bedell, F., transformer regulation, 357
Bedell, F., R. M. Klein, & T. P. Thompson, transformer plates, 622
Bedford, T. G., dilatation of porcelain, 1880
Beggs, J. J., single and double truck cars, 629, 379
Behn, U., specific heats, 258
Behn-Eschenburg, H., electrolytic conduction, 1503
Behrend, B. A., dynamo design, 1262
Behrendsen, O., Becquerel rays, 1867 ; coherers, 293
Beilstein, 871
Beim, 737
Bein, W., ionic migration, 732, 1234
Bekaert, A., & A. v. Hemptinne, reaction velocity, 1200
Bell, 972, 1242, 1310
Bell, L., light electric railways, 1810
Bellagamba, G., magnetometer observations, 1933
Bémont, G., Mme. P. Curie, & P. Curie, new radio-active element, 664
Bénard, H., & E. Mascart, rotatory power of sugar, 1401
Bender, C., refractive index of water, 1471
Benischke, G., charging for alternating current supply, 1819 ; stroboscopic determination of speed, 1116
Benjamin, C. H., workshops, 1281
Benndorf, H., dielectric hysteresis, 94
Benndorf, H., & P. Schoop, accumulator tests, 1068
Benz, electric railways, 1986
Berchem, 1336
Berg, E. J., alternating current motors, 1087 ; power transmission, 194 ; regulation transmission, 195
Berg, O., kathode and canal rays, 1900
Bergmann, 954
Berkenbusch, F., flame temperatures, 670
Bernard, E., selector system of circuits, 1997
Bersey, 1600
Berson, 1123
Berthelot, 585, 1949 ; ancient mirrors, 650 ; chemical actions of brush discharge, 1050
Berthelot, D., compressibility, 1153 ; dilatation of gases, 1006 ; molecular weights, 721, 1209 ; molecular weight and density of fluids, 541
Bertrand, 339
Besso, 890
Betti, 1908
Bezold, 71
Bianchi, E., diathermancy of ebonite, 673
Bidwell, S., multiple images, 790
Bigelow, F. H., temperature and vapour gradients in the atmosphere, 1644
Bignami, E., water-power in Italy, 1587
Bigourdan, G., earth tremors, 1468
Bijur, J., searchlights, 759
Biltz, W., cryoscopic behaviour of alcohols, 1747 ; cryoscopic investigation, 857
Binz, A., formation of indigo-white, 154 ; indigo-vats, 153
Bird, Hargreaves-, 873, 1410
Birdsall, E. T., electric drawbridge contact, 1569 ; traction, 1436
Bissing, W., wireless telegraphy, 1109
Bjerknes, 117, 690, 1336
Black, R. R., measurement of resistances containing earth currents, 825
Blackman, 873
Blackmore, 873
Blackstone, J. W., wattmeter for triphase currents, 705
Blackwell, R. W., tramways in Great Britain, 1810
Blakesley, 1374
le Blanc, 302, 700, 1949 ; accumulators, 1743
Blavier, 1707
Blondel, 710
Blondel, A., "Antennæ" in wireless telegraphy, 460 ; coherers, 457 ; electric arc, 678 ; metal-carbon arcs, 680 ; oscillographs, 1510 ; standards of light, 417 ; Wehnelt's interrupter, 1184
Blondin, J., Diatto surface contact system, 1992 ; sterilisation of water by ozone, 1755 ; syntonic coherer telegraph, 1108
Blondlot, 1903
Blondlot, R., electrical quantity, 1502 ; electromotive force on mixing liquids in a magnetic field, 1733 ; E.M.F.

produced in flame by magnetic action, 1527
Blood, J. B., train resistance, 1303
Boas, 1182
Boccara, V., lines of force, 813
Boccara, V., & A. Gandolfi, Hertzian waves, 459
Boccara, V., & M. Pandolfi, dielectromagnetic media, 1528
Bochet, lightning arresters, 1957
Bock, A., blue steam jet, 1852
Bodländer, G., solubility and heat of formation of electrolytes, 726
Bogojawlensky, A., crystallisation, 1197
Bogojawlensky, A., & G. Tammann, electrolytic conduction, 733
Böhm-Raffay, B., return feeders for electric railways, 1811
Bohr, C., solution of gases in liquids, 1738
du Bois, H., 324, 715; boiling-points, 1040; theory of magnetism, 1042
Boisbaudran, 1145
Boltzmann, 808, 1013, 1121, 1701
Boltzmann, L., sp. heats of gases, 666
Boltzmann, L., & H. Mache, Van der Waals' equation, 1493
le Bon, G., dark light, 548; residual luminescence, 550; transparency to Hertzian waves, 1500
le Bon, G. & E. Branly, absorption of waves, 1167
Bonacini, radiography, 433
Bonacini, C., & R. Malagoli, Röntgen rays, 1352, 1353
Bonetti, L., vacuum tubes, 81
Bongiovanni, G., longitudinal waves, 410
Booth, F. B., electric brakes, 1297
Booth, T. B., & S. S. Sherman, American motor-cars, 1817
Borchers, W., position of industrial electro-chemistry, 1947
Bordier, H., & Salvador, electrolytic actions near Crookes tubes, 1496
Borel, A., magnetic polarisation of quartz, 1142
Borgmann, I. I., & A. A. Petrovsky, capacity, 1501; measuring capacities, 1029
de Bort, L. T., meteorological registration by kites, 1642; temperature variations in the atmosphere, 1843
Bose, 1182
Bose, E., electrolysis, 1235
Bose, E., & W. Nernst, osmotic theory of the galvanic cell, 863
Bose, J. C., cohering action of metals, 1716
Bosi, 577
Bottomley, 1017
Bouasse, H., ductility of copper, 539; torsion, 1316
Boucherot, measuring torque, 745
Boudouard, O., & H. Le Chatelier, radiation from gas mantles, 41
Bouquet de la Grye, A., exploring balloons, 1123
Bourdréaux, E., electric fields, 1157
Bouty, E., conduction in rarefied gases, 1893
Bow, 224
Bowen, M. K., rails and rail-joints, 1810
Bower, J., & R. H. Jones, pressure on collision of two explosion-waves, 408
Bowie, A. J., three-phase four-wire system, 1790
Boyd, J. E., resistance of the human body, 96
Boynton, W. P., induction coil, 120
Boys, C. V., 1841
Bradbury, R. H., reaction velocity, 1538
Bradley, 1248
Branly, 1498
Branly, E., ball coherers, 1164; coherers, 693; contact resistance, 296; Hertzian oscillations, 90
Branly, E., & G. Le Bon, absorption of waves, 1167
Brashear, 1472
Braun, 1514
Braun, G., Düsseldorf-Krefeld electric railway, 1808; Siemens and Halske conduit systems, 370
Bravais, 1130, 1850
Bredichin, T., experimental reproduction of phenomena exhibited by comets, 985
Bredig, 1230; chemical applications of the arc, 146; electrolysis, 1941
Breisig, F., capacity of cables, 1172; long transmission lines, 1791
Breitenbach, P., viscosity of gases, 775
Breitfeld, C., induction motors, 1179
Breithaupt, G., gold and platinum mirrors, 1329
Bretonneau, 1082
Brett, W. P., wireless telegraphy, 1452
Bright, C., Pacific cable, 966; wiring rules, 748
Brill, J. A., tramcars, 1810
Brillié, L., & C. Vigreux, differential arc lamp, 1447
Brillouin, M., deformations of metals, 640; friction of smooth bodies, 977
Broca, A., anode rays, 565; discharge in a magnetic field, 815; vibration of apparatus, 537; wireless telegraphy, 460, 965
Broca, A., & P. Pellin, spectroscope of fixed deviation, 1480, 1865
Brocksmith, J. C., rectifier, 1786
Brown, A. C., wireless telegraphy, 1452
Brown, C. E. L., 1765
Brown, E. W., hydrodynamics, 648

Brown, H. P., electrolysis of cast-iron pipes, 614
Brown, J., contact force, 1019
Brown, N. H., photographic study of the arc, 1720
Brown, R. P., & G. E. Chapin, rail-bonding, 526
Browne, 1421
Browne, W. H., Jr., tachometer, 979
Brühl, 731
Brühl, J. W., dissociative power, 861
Brunelli, L., economy in charging accumulators from primary batteries, 636
Bruni, G., equilibrium of two- or three-component systems, 486; mixtures of isomorphous bodies, 485; mixtures of optical isomers, 1402
Bruning, 873
Brunn, barometer, 1321
Brunner, 1152
Brunswick, E. J., & M. Aliamet, permeameter, 114
Brush, C. F., 717; etherion, 325
Bruton, F., waste of fuel, 1081
Buisson, H., velocity of particles in discharge by ultra-violet light, 450
Bullier, 598
Bunsen, 1046
Bunte, 41; theory of Welsbach mantle, 242
Burbank, J. E., & J. Trowbridge, absorption of Röntgen rays, 1487
Burdick, 957
Burgess, C. F., capillary electrometer, 111; cleaning by electrolysis, 599; efficiency of electrolytic vats, 874
Burgess, G. K., & H. M. Goodwin, osmotic pressure, 480
Burghardt, 1242
Burke, J., absorption and fluorescence, 1350
Burnie, W. B., & C. A. Lee, conductivity of arc and oxides, 1504
Butler, C. P., & Edser, E., prismatic spectra, 249

Cady, H. P., E.M.F. between amalgams, 727; solid solutions, 1205
Cahen, A. A., & J. M. Donaldson, accumulator charging, 159
Cailletet, 262, 698, 1689, 1874
Calame, P., ionisation, 1229
Caldwell, 1918, 1942
Caldwell, E. W., Wehnelt interrupter, 1517
Caldwell, F. C., permeability of cast iron, 711
Callendar, 84, 1012, 1017, 1507, 1508
Callendar, H. L., comparing low resistances, 697; curve tracer, 127; platinum thermometry, 1011
Callendar, H. L., & H. T. Barnes, specific heat of water, 1879
Calzolari, F., & F. Garelli, cryoscopic behaviour of substances, 1543
Cameron, F. K., equilibrium of stereo-isomers, 487
Camichel, C., thermal ammeter, 827; thermal mercury ammeter, 118
Campbell, 1513
Campbell, A., dynamo without brushes, 1268; induction in measuring instruments, 831
Campbell, E. D., diffusion of sulphides through steel, 137
Campbell, E. D., & E. C. Champion, determination of tin, 152
Campbell, W. W., stellar velocities, 233
Cancani, A., earthquakes, 781; seismometrographs, 1634
Cannizzo, F., & O. M. Corbino, dielectric constant of indiarubber, 571
Cantone, 271
Cantor, M., coexistent phases, 719; vacuum discharges, 564
Canzoneri, 852
Capstick, J. W., kathode fall of potential, 83
Cardew, P., & A. P. Trotter, electric tramways, 212
Carhart, H. S., standards, 109
Carnelley, 593
Carpenter, R. C., wrought iron at high and low temperatures, 1621
Carpenter, R. C., & E. C. Sickles, flow of steam through pipes, 1428
Carpentier, 710
Carpentier, J., Wehnelt interrupter, 1518
Carré, F., Joule's law, 807
Carson, J., & W. E. Adeney, Rowland grating, 247
Carty, 972
Carus-Wilson, C. A., electric traction, 625, 935
Carvallo, 23
Carver, D. F., track construction, 946
Carveth, 487
Carveth, H. R., mixed vapours, 1391; single potential differences, 102
Caselli, 1607
Caspari, 1941
Cassel-Hinman, 1410
Castner, 598, 873, 1410
Cauchy, 1674
Cauderay, 897, 1421
Cawley, 616
Chabaud, V., radiography, 799
Chamen, electricity works, 1798
Champion, E. C., & E. D. Campbell, determination of tin, 152
Chandler, 1645
Chapin, E. S., & A. A. Noyes, binary electrolyte, 1231
Chapin, G. E., & R. P. Brown, rail-bonding, 526

Chapman, 1964
Chapman, D. L., explosion in gases, 776
Chappuis, 1006
Charpy, G., deformation of metals, 226
Chassy, A., polarisation, 698
le Chatelier, 482, 593, 1874
le Chatelier, H., dilatation of iron and steel, 1881; expansion of alloys, 1530; transformation of iron and steel, 1837; transition-points, 1935
le Chatelier, H., & O. Boudouard, radiation from gas mantles, 41
Chatterton, 1065
Chattock, A. P., & S. R. Milner, conductivity of water, 1356
Chauveau, atmospheric electricity, 70; theories of atmospheric electricity, 1704
Chauveau, A., biological thermodynamics, 1691; elasticity of muscle and of rubber, 643; muscular elasticity, 411
Chedville, 901
Chester, 1026
Chiacaviglio, 1937
Child, C. T., electrical instruments, 1032; electric power for marine propulsion, 1771; Wehnelt interrupter, 1517
Chree, C., aneroid barometers, 1115
Christiansen, 22
Chubbuck, L. B., interior wiring, 1254
Churchill, J. B., & T. W. Richards, thermometric fixed points, 1010
Cicott, F. X., commutator segments, 353
Clamer, 1395
Clapeyron, 801, 806
Clark, E. B., electric power in steel-making, 1969
Clark, W. J., American electric railways, 1810
Clarke, 1170, 1505
Clarke, S. S., & W. S. Franklin, normal curve of magnetisation, 1926
Claude, G., acetylene, 1206
Clausen, H. P., combined telephone and electric light stations, 396; switchboard for toll lines, 969; telephone equipment, 391; telephone exchanges, 1458; telephone troubles, 1611
Clausius, 62, 806, 807, 1133, 1392, 1908
Clayton, H. H., periodicity in the weather, 1641
Clement, 1371
Clerk-Maxwell, *see* Maxwell
Coehn, 273
Coehn, A., contact electrification, 1020; electrolytic evolution of hydrogen, 1941
Cohen, 1201
Cohen, E., Clark cells, 1507; reaction-velocity, 1201, 1936
Coho, H. B., traction, 1436
Coker, E. G., measurement of twisting strains, 642
Colard, induction in telephone circuits, 1609
Colard, M., van Rysselberghe's combination, 1453; van Rysselberghe's system, 1454
Cole, A. D., electric waves, 568
Cole, R. S., & A. M. Worthington, impact with a liquid surface, 1624
Coles, Cowper-, *see* Cowper-Coles
Colin, P., magnetic and geodetic observations in Madagascar, 474
Collardeau, 698
Comboul, 737
Comly, 1241
Compan, P., transmission of light, 1133
Conant, R. W., cost of electrical energy, 368
Conaty, G., electric tramways, 1439
Condict, G. H., motor-cars in New York, 1103
Conroy, J., refractive indices of chloride solutions, 1136
Constable, A. D., Raymond-Barker's insulation test, 826
Cook, E. H., brush discharge, 814
Cooke, A. G., Caldwell interrupter, 1918
Coolidge, W. D., dielectric constants, 1906; electric wire-waves, 689
Cooper, H. C., & H. Goldschmidt, solubility of the carvoximes, 138
de Coppet, L. C., maximum density of solutions, 1626
Corbin, 598, 1760
Corbino, 246, 271, 422, 424, 426, 464, 545, 1340
Corbino, O. M., Zeeman effect, 1477; Zeeman phenomenon, 793
Corbino, O. M., & F. Cannizzo, dielectric constant of indiarubber, 571
Corbino, O. M., & D. Macaluso, light traversing metallic vapours in a magnetic field, 425, 427; radiation in a magnetic field, 792
Cornu, 423, 1345, 1478, 1620
Cornu, A., Fizeau's researches, 12
Cory, C. L., regulation of alternating current generators, 1974
Coster, M., traction, 1436
Cotsworth, 389
Cottle, G. J., & A. A. Noyes, reaction velocity, 1199
Cotton, A., absorption in a magnetic field, 422; Kirchhoff's law, 1851; magnetic double refraction, 545
Cottrell, H. E. P., traction, 1985
des Coudres, T., harmonic analyser 1035
Coulomb, 1762

Couriot, H., & J. Meunier, incandescent filaments, 608
de Courmelles, F., therapeutic use of Crookes tubes, 1351
Cowper-Coles, 156, 345, 598, 738, 1410, 1757
Cowper-Coles, S., deposition of cadmium, 339; deposition of chromium, 340; deposition of vanadium, 869; electro-deposition of palladium, 1749; electro-metallurgy, 490; galvanising, 342
Cozens-Hardy & O'Gorman, paper telephone cables, 1455.
Crandall, C. L., electric power from windmills, 1818
Crane, 1241, 1311
Cravath, J. R., Chicago Elevated Railway, 521; cost of rapid transit, 1440
Crees, 878
Crehore, 14
Crellin, 1026
Crew, H., & O. H. Basquin, source of luminosity, 543
Crompton, R. E., wiring rules, 748
Crookes, 455, 1475
Crookes, W., etherion, 717; uranium radiation, 549; victorium, a new element, 1737
Crova, A., actinometers, 55, 1334
Curie, 1682
Curie, P., Mme. P. Curie, & G. Bémont, new radio-active element, 664
Curie, P., & Mme. Sklodowska-Curie, radio-active element, 35
Curie, Mme. Sklodowska-, magnetised bars, 133; magnetic properties of tempered steel, 134
Cutten, 873

Dailey, S. H., high-pressure lines, 173, 613
Dales, 1751
Dammeyer, 739
Damon, G. A., Central Station at St. Louis, 204; electricity in printing, 512
Danielson, E., compounding of alternators, 1086
Darling, J. D., Harrison lead peroxide battery, 1414
Darwin, 18
Dary, G., prevention of collisions at sea, 1075
Davey, C. B., balancers, 1269
Dawson, H. M., & J. H. van't Hoff, formation of tachydrite, 1939
Dawson, H. M., A. Smithells, & H. A., Wilson, conductivity of flames, 574
Dawson, P., electric traction, 935
Day, A., & L. Holborn, air thermometer, 1873
Debell, E. L., meter rates, 1445
Décombe, L., dispersion in a vacuum, 544; electric discharge, 78; multiple resonance, 690
Delaunay, 18
Dell, A. G., induction-coil condenser, 119; new form of coherer, 1719; self-induction experiments, 1386
Delvalez, L., coloured photographs, 31
Demerliac, fusion, 801
Demarçay, M., radium, 664
Dennhardt, R., fluidity and conductivity, 1061
Depeissis, 739
Déri, 505
Desains, 1339
Desaymar, 1821
Desdouit, 1596
Deslandres, H., 988; chromosphere, 1839; stellar radial velocities, 1648
Deslandres, H., & H. Becquerel, Zeeman phenomenon, 32, 33
Desonnes, 1371
Dessau, 271, 464
Dessauer, F., interrupters, 1182; interrupter, 1183
Dettmar, G., 1266, 1273; dynamo losses, 1430; friction losses in dynamos, 1775
Deussen, E., uranyl salts, 248
Dévé, C., oscillating focometer, 1658
Deville, 1063
Dewar, 834
Dewar, J., boiling-point of hydrogen, 668, 1489; colour of iodine vapour, 785; high vacua by liquid hydrogen, 592
Dewar, J., & J. A. Fleming, susceptibility of liquid oxygen, 470
Diatto, 1992
Dieffenbach, 598, 1757
Dieterici, 1223
Dieterici, C., freezing-points, 143; kinetic theory of liquids, 263; osmotic pressure, 1541; vapour pressure of solutions, 843
Dietz, R., & W. Dittenberger, electrolysis of platinum chloride, 1944
Dietzel, A., treatment of gold-silver alloys, 1759
Dieudonné, E., swing-bridge crossing, 365
Dina, A., thermal conductivity of ebonite and glass, 1684
Ditte, 1532
Ditte, A., aluminium, 847; chemical properties of aluminium, 1064; properties of aluminium, 1531
Dittenberger, W., & R. Dietz, electrolysis of platinum chloride, 1944
Dix, H. W. W., heating of commutators, 1574
Dixon, 776
Doane, S. E., incandescent lamps, 388

Dobbie, J. J., & W. N. Hartley, absorption spectrum of benzene, 1675
Dobbs, A. E., telephone distances exceeding the K.R. Law, 535; telephone work, 225
Dodge, N., & L. C. Graton, three-component system, 484
Dolezalek, 1743
Dolezalek, F., accumulators, 1546
Dommer, F., liquid air, 1360
Donaldson, J. M., & A. A. Cahen, accumulator charging, 159
Dongier, R., quartz plate normal to the axis, 656; rotatory power of quartz, 23
Donle, 1853
Donle, W., pressure due to radiation, 1475
Donnan, F. G., hall effect in an electrolyte, 1384; isothermal pressure-surface, 594
Donner, W. H., mnemonic for conductor resistance, 1073
Donovan, 1949
Doppler, 988
Dorn, E., coherers, 106; Röntgen rays, 253
Doubt, T. E., colour measurement, 240
Dow, A., traction, 1436
Downing, G. M., & S. Sheldon, magnetic effect of electrolytic currents, 305
Drake, 873, 1242
Drake, B. M., electric lighting of country houses, 1104; wiring, 748
Drechsel, 1943
Dresser, C. A., motors in printing, 1425
Drude, 288, 1140, 1499; electric oscillations, 89
Drude, P., magneto-optic phenomena, 1481
Dubois, resistance of the human body, 97
Dubosc, 873
Dubreuil, multiple switchboard, 968
Ducretet, E., Hertzian telegraphy, 534
Duddell, W., & E. W. Marchant, alternate arcs, 829
Duff, 1371
Dufour, 1354
Duhem, 1219, 1490, 1686
Duhem, P., thermodynamics, 1354
Dulong, 499
Dumas, L., magnetic transformation-point of nickel alloys, 1929
Dumont, E., nickel steels, 320
Dumont, G., Germain's loud-speaking transmitter, 1833; transmitter working with 20 volts, 2000
Duncan, L., F. B. Keidel, W. L. Hodges, & E. Frank, transformer losses, 1580
Durban, 878
Durward, A., aged magnets, 132
Dussaud, electrical transmission of sound, 560; loudness of phonograph, 556; radiophony, 557; relief pictures for the blind, 236
Dutoit, 731
Dvorak, 1836

Ebel, J., electric alarms, 606
Ebert, 117, 1649
Ebert, H., energy consumed in vacuum tubes, 684; Hittorf's dark space, 1897
Eddy, H. T., alternating currents, 124
Eddy, H. T., D. C. Miller, & E. W. Morley, velocity of light in a magnetic field, 1667
Edison, 1569, 1602
Edlund, 1704
Edmondson, 1378
Edser, E., Maxwell's theory, 784
Edser, E., & C. P. Butler, prismatic spectra, 249
Egger, E., electric motor cars, 1598
Egoroff, 1858
Eichberg, F., braking induction motors, 755; Görges phenomenon and coupling of motors, 753; Wehnelt interrupter, 1517
Eichberg, F., & L. Kallir, electric arc, 679, 830
Elbs, 1236
Elbs, K., theory of accumulators, 1743
Elbs, K., & B. Schwarz, reduction of m-nitro-p-toluidine, 336
Elbs, K., & O. Kopp, formation of azo- and hydrazo-compounds, 334
Ellis, R. L., wiring chart, 165
Elsner, 342
Elster, J., 1867
Elster, J., & H. Geitel, Becquerel rays, 254, 1866
Emden, R., efflux of gases, 1836
Emery, C. E., engines for power stations, 495
Emmet, W. L. R., safety devices in electrical distribution, 1763
Emmot, 1421
Engelhardt, V., electrical bleaching, 1948
Epstein, J., hysteresis loss in core-discs, 1572
Ercolini, G., dielectric constant of stretched glass, 464; heat developed on wetting powders, 845
Erens, F., starting and braking resistances for traction motors, 1767
Ericson, 1202
Erlacher, 890
Ernecke, 1182
Erskine, J. A., dielectric constants, 272
Erzbach, Müller-, W., molecular forces, 774; vapour pressures, 142
Eschenburg, H., Behn-, electrolytic conduction, 1503

Eschenhagen, M., magnetic elements, 721 ; magnetic elements of Potsdam, 1934
Eskmann, 340
Esmond, 372
Esson, 179
Esson, W. B., electric transmission in mining, 921
Ettinghausen, 822
Euler, H., dissociation and dielectric constants, 1940
van Everdingen, 1024
Everett, J. D., optical phenomena, 237
Everett, W. H., & A. H. Peake, effect of commutation on field, 751
Evershed, 1421, 1450
Evershed, S., space telegraphy (inductive), 961
Ewers, P., kathode and canal rays, 1899
Ewing, 710, 1925
Ewing, J. A., & W. Rosenhain, structure of metals, 1196
Ewing, S. E. T., distribution by alternating currents, 763
Exner, 303

Fabre, 1875
Fabry, 250, 419
Fabry, C., & A. Perot, absolute electrometer, 315 ; electrostatic voltmeter, 586 ; interference applied to metrology, 1643 ; interferential measurement, 980 ; monochromatic light, 1470 ; fringes, 24, 25 ; spectra, 1143
Fabry, C., J. M. de Lépinay, & A. Perot, measurement of length, 1112
Fahrig, 739
Faraday, 66, 323, 676, 1021
Farr, C. C., magnetic force in solenoids, 1018
Faure, 873
Fawcett, F. B., resistance standards, 1187
Fay, T. F., electrical refrigeration, 612
Federico, R., electrolytic polarisation, 466 ; measurement of electrolytic conductivity, 108 ; polarisation, 699 ; polarisation of de-ærated water, 1725
Feldmann, 1421
Feldmann, C. P., dynamo regulation, 1265 ; electric traction, 1438
Fenner, M. M., by-products of power plants, 615
Ferguson, L. A., distribution, 198 ; underground mains, 1792
Ferranti, 1421
Ferry, E. S., spectra of gases, 40
Féry, galvanometers, 1511
Féry, C., movable-coil galvanometers, 704 ; photometric standard, 29
Fessenden, R. A., candle-power of glow-lamps, 1128 ; Methven standard, 1127
Field, 890 ; induction motors, 1275
Filon, L. N. G., diffraction fringes applied to micrometric observations, 1666
Fischer, K. T., least thickness of liquid films, 1625
Fischer-Hinnen, J., electrical steering-gear, 492 ; friction losses in dynamos, 1776
Fitzgerald, 1139, 1341
Fitz-Gerald, D., accumulator construction, 161, 884, 1417
Fitz-Gerald, M. F., flying, 1325
Fizeau, 12, 249, 655
Fizeau, 3
Fleming, 834
Fleming, J. A., corrosion by earth currents, 218 ; wireless telegraphy, 1452
Fleming, J. A., & J. Dewar, susceptibility of liquid oxygen, 470
Fleury, A., relative merits of glass and porcelain as insulators, 1251
Florian, 832
Focke, 804
Focke, T. M., thermal conductivities of glass, 440
de Fodor, E., precursors of Nernst's lamp, 1602
Foerster, electrolysis of alkali chloride solutions, 1946
Foerster, F., electricity direct from carbon, 308 ; electrolysis of copper sulphate, 1548
Foerster, F., & O. Günther, electrolysis of zinc chloride, 151
Fogh, 1946
Folgheraiter, G., magnetic inclination, 839, 1039 ; magnetic inclination in ancient times, 1734
Fomm, 1870, 1871
Fomm, L., vacuum phenomenon, 1712
Forbes, 1685
Forbes, G., power transmission, 760 ; transmission in mining, 921
Forch, C., surface tension, 1834
Ford, 1505
Ford, A. H., hysteresis, 1925
Forde, 1170
Forel, F. A., apparent horizon, 1842
de Forest, L., Hertzian waves, 1903
Forster, 1408
Foster, W., Jr., conductivity of electrolytes, 1545 ; hydrolysis of stannic chloride, 1938
Foucault, 240, 249
Frank, E., L. Duncan, F. B. Keidel, & W. L. Hodges, transformer losses, 1580
Frankland, P., photographic action of swing structures, 255
Franklin, W. S., 1927
Franklin, W. S., & S. S. Clarke, normal curve of magnetisation, 1926

Fraunhofer, 1328
Fry, 598
Fuchs, 1480
Fuchs, P., aspiration-thermometer, 805
Fulmen, 602, 1599

Galileo, 1336
Gall, 343, 873, 1239
Galt, A., M. Maclean, & Kelvin, electrification of air, 1494
Gamba, P., deformation of marble, 641; flexibility of marble, 771, 1317
Gambrell, 1509
Gandolfi, A., & V. Boccara, Hertzian waves, 459
Gannon, 109, 1366
Garbasso, 690, 1336
Garbasso, A., discharge of condensers, 76; electricity and fog, 449
Gardner, H. N., electricity in coal-mines, 1960
Garelli, F., cryoscopic solvents, 479
Garelli, F., & F. Calzolari, cryoscopic behaviour of substances, 1543
Gaster, L., traction, 935
Gauss, 1118
Gautier, A., atmospheric hydrogen, 477
Gautier, P., large speculum, 1657; Paris Exhibition siderostat, 1845; siderostat, 1131
Gavey, J., wireless telegraphy, 1452
Gebauer, 1948
Geigel, R., polarisation, 1855
Geipel, W., three-phase installation, 363
Geissler, 1152, 1501
Geitel, H., 1867
Geitel, H., & J. Elster, Becquerel rays, 254, 1866
von Geitler, J., Röntgen and kathode rays, 37
Gelcich, E., Florian's compass, 832
Georgiewsky, 1858
Gerard, E., & O. de Bast, enclosed arc lamp, 1605
Gerbes, 1943
Germain, 1833, 1953
Gibbings, A. H., electric motive power, 202
Gibbon, T. H., track construction, 632
Gibbs, 592, 1217, 1320, 1491, 1492, 1536
Gibson, J. S., Joly colour-photography process, 30
Giesel, F., radio-active baryta and polonium, 1868
Giles, 492; electricity works, 1798
Gill, D., stellar atmospheres, 1650
Gill, J. L. W., magnetic induction, 1192
Girault, P., curve of accumulator charge, 880
Gladstone, J. H., & W. Hibbert, absorption of Röntgen rays, 1003
Glaisburg, earth returns, 1984
Glaser, 341
Glazebrook, 314
Glenn, W. H., preservation of sleepers, 633
Glukoff, 873
Gnesotto, T., microseismograph, 1635
Goddard, 244
Goldhammer, D. A., Zeeman phenomenon, 659
Goldsborough, W. E., magnetic flux in dynamo air-gaps, 909; transformer core losses, 1783; transformer economy, 190; transformer tests, 1784
Goldschmidt, 1202
Goldschmidt, H., high-temperatures by aluminium, 1950
Goldschmidt, H. (G. v. Maarseveen), solubility, ionisation, and heat of solution, 1056
Goldschmidt, H., & H. C. Cooper, solubility of the carvoximes, 138
Goldschmidt, H., & R. M. Salcher, organic bases in aniline, 1535
Goldstein, 1900
Goldstein, E., kathode and Lenard rays, 456
Goodwin, H. M., & G. K. Burgess, osmotic pressure, 480
Goodwin, H. M., & M. K. Thompson, Jr., electric properties of ammonia, 465
Gordon, 1528
Gordon, C. McC., ionisation of fused salts, 728
Gordon, C. McC., L. J. Henderson, & W. L. Harrington, boiling-points of mixed solutions, 1054
Gore, 878
Gorgensen, 873
Görges, 753
Gosselin, potentiometers, 828
Gough, H. E., & E. B. Paine, transformer for 150,000 volts, 188
Gourwitch, L., voltameter, 1188
Gouy, 1649, 1838
Grabau, 1242
Gradenwitz, A., capillary constants, 644
Graetz, 1090, 1146
Graetz, W., & H. C. Schwecke, bichromate cells, 307
Graftio, H., train resistance, 1596
Graham, 1901
de Gramont, A., spectroscope with variable scale, 1677
Grassi, G., armature design, 750
Graton, L. C., & N. Dodge, three-component system, 484
Grau, A., eddy currents and hysteresis, 473
Gray, 1341
Gray, P. L., & J. H. Poynting, directive action of one crystal on another, 777

Gray, T., dielectric strength, 572
Greatorex, A. D., electric traction, 1982
Green, 676
Green, J. J., wireless telegraphy, 1996
Greene, S. D., electricity on board ship, 759
Greenwood, 598, 737, 873
Greenwood, G. F., power station at Pittsburg, 1094
Gressman, G. W., resistance of lead amalgams at low temperatures, 824
Griffin, B., cork electric tramways, 206
Griffith, 109
Griffiths, 1012, 1366, 1507
Griffiths, A., diffusive convection, 406, 1318; rate of diffusion, 1319
Grimaldi, 1387
Grimaldi, G. P., & G. Platania, polarisation of metallic foil, 580
Grindberg and Haber, electrolysis of hydrochloric acid, 1752
Groll, 1751
Gröndal, 1951
Gross, 332
Grubb, 244
Grunmach, L., density and ductility, 399; surface tension, 1315
Grützmacher, F., thermometric corrections, 1872
Guébhard, the "green ray" after a red sunset, 1646
Guest, 1102
Guglielmo, G., Geissler pumps, 647; kathode and Röntgen rays, 818; Röntgen rays, 429
Guilbert, C. F., alternate current motors, 1577; capacity in alternating current circuits, 709; dynamos, 1433; dynamo-electric machinery, 1270; starting devices for motors, 756; transformers, 191
Guillaume, 320, 1525
Guillaume, C. E., nickel and its alloys, 234; nickel steel, 1523
Guillet, A., maintenance of pendulum motion, 5
Guillet, V., bar magnets, 1195
van Gulik, D., coherers, 105
Gumlich, 665
Gumlich, E., temperature regulator, 1151
Gumlich, E., & H. F. Wiebe, specific heat of liquids, 259
Günther, O., & F. Foerster, electrolysis of zinc chloride, 151
Guthe, 109
Guthe, K. E., polarisation and resistance of cells, 578
Guthe, K. E., & G. W. Patterson, Jr., electro-chemical equivalent of silver, 1727
Gutton, C., electromagnetic waves, 93; velocity of electric waves, 1498
Guye, C. E., alternate currents, 123
Gylden, 18

Haber, 341, 1946
Haber, F., preparation of β-phenylhydroxylamine, 333
Haber & Grindberg, electrolysis of hydrochloric acid, 1752
Hadfield, 1525
de Haën, 1868
de Haën, E., new radio-active substance, 1682
Haga, H., & C. H. Wind, diffraction of Röntgen rays, 1871
Hagen, 739
Hagen, E., & H. Rubens, metallic reflection, 992
Hagenbach, 1623
Hale, G. E., heat radiation of the stars, 1841
Hale, R. S., & H. J. Williams, calorific power of weathered coals, 499
Hall, 957, 1481, 1947
Hall, E. H., resistance of moving electrolytes, 577
Hall, E. H., & C. H. Ayres, conductivity of cast iron, 1357
Hall, T., shaft governor, 176
Hall, W. H., armature testing, 1432
Halliday, G., transmission of heat, 57
Hallopeau, L. A., electrolytic crystallised tungsten, 488
Hallwachs, W., trough refractometer, 1333
Halsey, E. S., maximum demand meter, 1561
Halske, 155, 342, 370, 623, 892, 1423, 1757
Hambley, 1051
Hammer, W. J., motograph as a telephone relay, 1613
Hamy, M., correction of micrometers, 2; measurement of diameters, 655; reference lines in spectra, 1673
Hanappe, S., rotary field motors, 185
Hanchett, G. T., arcs and non-arcing metals, 886; electric railway motors, 187; Wehnelt interrupter, 1517
Hann, 1126
Hann, J., temperatures on mountain-tops, 782
Haralson, J., Jr., instantaneous contact-maker, 1920
Harding, W. A., traction costs, 525
Hargrave, 1642
Hargreaves-Bird, 598, 873, 1410
Harkness, W., arc light formulæ, 952
Harrington, W. L., L. J. Henderson, & C. McC. Gordon, boiling-points of mixed solutions, 1054
Harrington, W. L., & T. W. Richards, boiling-points of mixed solutions, 1053

Harris, R. A., tidal analyser, 540
Harting, 1327
Harting, H., aberration in astronomical telescopes, 1656; objectives, 786, 787; telescope objectives, 1844
Hartley, W. N., & H. Ramage, gallium in the sun, 1840
Hartley, W. N., & J. J. Dobbie, absorption spectrum of benzene, 1675
Hartmann, J., Kirchhoff's solar spectrum, 796; photometer, 1660
Haschek, E., & H. Mache, pressure within the spark, 1891
Hasselberg, 1345
Hastings, C. S., telescopic objective, 1472
Hawkins, C. C., induction motor diagrams, 915; motor diagrams, 1277
Hay, A., current-rushes in transformers, 193
Haycroft, 1410
Hayes, 1311
Hayford, J. F., tidal problem, 779
Haywood, J. K., boiling-points of liquids, 1542
Heath, 890
Heaviside, 284, 676, 962, 1162
Heaviside, O., electromagnetic theory, 68, 812
Heberle, 1951
Hecker, A., electric traction statistics, 1983; magnets instead of springs, 1300
Hefner-Alteneck, 16
Heft, H. N., New Haven and Hartford electric railways, 366
Heim, polarisation, 107
Heinke, C., transformer problems, 1581
Heldt, P. M., stresses in slotted armatures, 1573
Hele-Shaw, H. S., fluid motion, 978
Helmert, compound pendulums, 402
Helmholtz, 102, 147, 240, 481, 727, 1162, 1336, 1674, 1852
Hempel, W., thermal insulation, 1358
v. Hemptinne, A., & A. Bekaert, reaction velocity, 1200
Hemsalech, G. A., spectra discharges, 1860
Hemsalech, G., & A. Schuster, constitution of electric spark, 1377
Henderson, J., cadmium standard cells, 1921
Henderson, L. J., C. McC. Gordon, & W. L. Harrington, boiling-points of mixed solutions, 1054
Henry, 1397
Henry, C., Actino photometer, 1661
Henry, J., deflection of electric discharge, 468
Henry, J. C., new controller, 529
Herbert, H., 1075
Herberts, H., detecting objects at sea, 347
Hering, 1132
Hermite, 598, 873
Hernek, 1757
Heroult, 1947
Herrick, A. B., earth returns, and electrolysis, 219; electrolysis in ground returns, 941; overhead line construction, 1987; street-car equipments, 1292
Herschkowitsch, M., alloys, 849
Hertz, 92, 564, 676, 965, 1154, 1169, 1336, 1715
Hess, W., induction-coils, 312
Heubach, J., theory of induction motors, 1976
Heycock, C. T., & F. H. Neville, Röntgen ray photography and alloys, 1394
Heydenreich, 338, 1751
Heydweiller, 1546
Heydweiller, A., contact electricity, 273; process of crystallisation, 1047
Heyn, E., metallography, 1395
Hibbert, W., & J. H. Gladstone, absorption of Röntgen rays, 1003
Hiecke, 1069
Hilbish, J. E., C. P. Matthews, & W. H. Thompson, the photometry of the enclosed alternating arc, 951
Hill, 1209; traction, 1436
Hill, C. W., balancing of armatures, 1267
Hillers, W., Röntgenised gases, 1485
Himstedt, F., high-frequency point discharges, 1708
Hinman, Cassel-, 1410
Hinnen, Fischer-, J., electrical steering-gear, 492; friction losses in dynamos, 1776
Hittorf, 147, 276, 340, 1897, 1901; electromotive behaviour of chromium, 1744
Hittorf, W., & H. Salkowski, new-class of inorganic acids, 1404
Hobart, 1574
Hobart, H. M., & H. F. Parshall, electric generators, 910; physical properties of metals, 981
Hodges, W. L., L. Duncan, F. B. Keidel, & E. Frank, transformer losses, 1580
Hoefner, 737
v. Höegh, E., telescope objectives, 1327
Hoepfner, 598, 873
L'Hoest, M., determining illumination, 791
van't Hoff, 149, 485, 727, 1056, 1202, 1390, 1392, 1544
van't Hoff, J. H., saturation-point of solutions, 1937
van't Hoff, J. H., & H. M. Dawson, formation of tachydrite, 1939

Hoffmann, 117, 1895
Hoffmann, W., expansion of air, 800
Hoffmann, H. W. & R. Apt, incandescent lamps, 99
Hoffmeister, 1058, 1405
Hoffmeister, H., conduction in electrolytes, 1060
Hoho, 1521
Holborn, L. & A. Day, air thermometer, 1873
Hollard, 870
Hollard, A., electrolytic estimation, 1237; estimation of lead, 596
Holzmüller, theory of electricity, 1155
Honda, K., & H. Nagaoka, magnetostriction, 714
Hookham, 1421
v. Hoor, M., slip in induction motors, 1579
Hopfgartner, 1058, 1060, 1405
Hopfgartner, K., conduction in electrolytes, 1059
Hopfner, 1757
Hopkins, N. M., U.S. electric lighting company's station at Washington, 511
Hopkinson, 1042, 1193, 1572
Hoppe, E., theory of accumulators, 1547
Horry, W. S., electric smelting, 158
Hospitalier, E., electric and petrol motor car, 1994; fulmen accumulators, 602; motor-cars, 383, 1816; motor-car trials, 382; systems of charging for electrical energy, 1765; Wehnelt interrupter, 1917
Hotchkiss, H. J., photographing curves, 1190
Houllevigue, L., axial field of a bobbin, 67; carbon in electrolytic iron, 865; magnetism, 1193; passive state of iron, 141
Houston, 1573
Houston, E. J., & A. E. Kennelly, alternating-current machinery, 911
Howe, J. L. & E. A. O'Neal, electrolytic formation of alums, 735
Howell, J. W., two-wire distribution, 199
Hubley, G. W., transformer core losses, 1785
Hüfner, G., diffusion of gases, 723
Hulett, G. A., transition between solid and liquid, 1392
Hulin, 1242, 1410
Hummel, 1421, 1607
Humphrey, 1649
Humphreys, W. J., Wehnelt interrupter, 1916
Hundhausen, R., standard threads and gauges for screw-socket lampholders, 170
Hunt, 1065
Hurmuzescu, D., Röntgen rays, 431
Hurmuzescu, transformations of Röntgen rays, 1004
Hutchins, C. C., irregular reflection, 993
Hutchinson, C. T., the electric railway motor, 1810
Hutin, 505
Hutton, 1345
Hyatt, 1080

Inman, M. L., accumulators for automobiles, 1761
Ives, 30
Izambard, 1256, 1257

Jablochkoff, 1602
Jackson, D. C., commutated current-wave of alternator, 183; polyphase currents for railways, 1810
Jackson, H., phosphorescence, 439
Jacques, 583
Jaeger, W., & St. Lindeck, manganin resistances, 110
Jäger, 1365, 1882
Jäger, G., kinetic theory of liquids, 1364, 1694
Jäger, G., & S. Meyer, magnetic susceptibility of water, 715, 836; susceptibility of liquids, 131
Jahn, 1052
Jahn, H., calculation of ionisation from conductivity, 1058; electrolytic polarisation, 302; polarisation, 1506
Jahr, E., action of electric currents on photographic plates, 984; chemical action of magnetism, 837
Janet, P., rectification of alternating currents, 125; rotary converters, 356; transmission of power, 359
Janssen, 989
Janssen, J., solar radiation, 19
Januszkiewicz, L., & W. Voigt, homogeneous deformation, 639
Jawein, 871
Jehl, F., manufacture of carbons, 169, 893; underground mains, 172
Jenatzy, 1599
Jenko, P., brightness of light, 994
Jenny, 215
Jewell, L. E., hydrogen lines in solar spectrum, 1862
Jobin, interferential spectroscopy, 250
Joel, 1295
Johnson, E. H., contact system, 522
Johnson, F. A., motor speed, 1278
Johonnott, E. S., Jr., black spot in liquid films, 1338
Joly, 30
Jona, E., 1174; detecting faults, 1173
Jones, 690
Jones, H. C., & H. M. Reese, conductivity of praseodymium and neodymium sulphates, 328

Jones, J. V., & W. E. Ayrton, ampere balance, 1186
Jones, R. H., & J. Bower, pressure on collision of two explosion-waves, 408
Jordan, A., and W. Schonau, localising faults, 1030
Jörgensen, 1404
Jorre, 1408, 1946
Joubert, 1084
Joule, 807
Jude, R. H., capacity of spheres in contact, 269
Jumau, L., accumulators, 310; capacity of accumulators, 1415
v. Jornstorff, H. J., solution theory of iron and steel, 848, 1742

Kabulokow, 1202
Kaeppel, 870
Kahle, 1366, 1727
Kahle, K., silver voltameter and standard cells, 112
Kahlenberg, L., & A. T. Lincoln, ionising power, 731
Kalähne, A., discharge spectra, 39
Kallir, L., rectification of currents, 1090; Wehnelt interrupter, 1517
Kallir, L., & F. Eichberg, electric arc, 679, 830
Kallmann, M., measurement of current leakage, 695; stray currents on electric railroads, 1301, 1984
Kann, L., luminous paint, 1349; rotatory polarisation of malic acid, 1141
Kapp, 179, 1276
Kapp, G., hunting of alternators, 1085; rotary converters, 1091; sparkless commutation, 1083; mining, 921
Kath, H., 114; magnetic qualities of iron, 591
Katz, 248
Kaufmann, 1162
Kauffmann, H., electric waves and electroluminescence, 1499
Kaufmann, W., deflection of kathode rays, 282; diffusion of kathode rays, 1898; momentary magnetisation, 1735
Keeley, D. H., electric siren, 1427
Keidel, F. B., L. Duncan, W. L. Hodges, & E. Frank, transformer losses, 1580
Keigwin, A. D., elastic properties of steel wire, 1617
Kelley, W. S., multiphase systems, 509
Kellner, 873, 1410, 1242, 1948
Kelly, J. F., preventing magnetic leakage, 346
Kelvin, 303, 414, 561, 695, 697, 1015, 1065, 1177, 1374, 1674, 1886, 1902; magnetism and molecular rotation, 1928; waves in an elastic solid, 1120, 1631; reflection and refraction of light, 783; Sellmeier's theory, 1672; wave motion, 1119
Kelvin, M. Maclean, & A. Galt, electrification of air, 1494
Kennedy, 1354; wireless telegraphy, 1451, 1452
Kennelly, 1573; Jacques cell, 701
Kennelly, A. E., & E. J. Houston, alternating-current machinery, 911
Kenney, 1610
Kent, 499
Kerr, 1139, 1857, 1859
Kershaw, J. B. C., 1065; alkali works, 1243; aluminium conductors, 1768; chlorate works, 343; copper depositing, 344; electrochemical and electrometallurgical industries in 1898, 598; electrolytic chlorate works, 1760; electrolytic zinc extraction, 1757; electrometallurgical industries of England, 872; relative cost of copper, aluminium, and iron as conductors, 164
Ketteler, 1330
Ketteler, E., air waves produced by a pendulum, 1698; magneto-optic phenomena, 1340; total reflection, 1134
Kidde, W., electrically operated drawbridge, 905
Kieseritzky, R., determinations of constitution, 1215
Kilduchevesky, 975
Kiliani, 342
King, C., Junfrau electric railway, 933
King, R. O., Thomson effect in copper, 575
Kinsley, C., frequency of alternating currents, 1513
Kippenberger, 862
Kirchhoff, 659, 714, 796, 808, 1016, 1330, 1848, 1851
Kistiakowsky, W., reaction aqueous alcohol, 1048
Kitsee, I., wireless telegraphy, 1830
Klein, C., optical characteristics of garnet, 1135
Klein, R., & C. Schall, electrolytic nitrobenzene, 866
Klein, R. M., T. P. Thompson, & F. Bedell, transformer plates, 622
Kleinschmidt, H. F. A., electric welding of rails, 1813
Klemenčič, 220
Klemenčič, I., hysteresis, 128; standard cells, 95
Knott, C. G., reflection and refraction of elastic waves, 1633
Knudson, A. A., 1241; electrical survey in New York city, 899; electrolysis by stray currents, 1074
Koch, 1521
Koch, K. R., gravity determinations, 780; improved barometer, 646

v. Kodolitsch, F., shipyard tools, 609
Koenigsberger, J., magnetic susceptibilities, 324
Koepsel, 712
Kohl, 1182
Kohlrausch, 330, 1404, 1546, 1874, 1944
Kohlrausch, F., 1230; electrothermal relations, 702; mobility of ions, 331
Kolbe, J., five-wire systems, 1589
Kolben, E., 1962
Kolle, F. S., printing by X-rays, 1257
Kollert, J., insulation of three-wire system, 1914
König, 1572
König, W., 1126; dispersion of selenite, 1849; electric oscillations, 688
Königsberger, 715, 1529
Konowalow, 719, 731, 1220
Kopp, 1236
Kopp, O., & K. Elbs, formation of azo- and hydrazo-compounds, 334
Korda, D., magnetism and thermal conductivity, 1041
Kösters, W., electric charge of electrolytic gas, 1887
Kraszler, S., & C. Schall, electrolytic dithio-disulphides, 867
Kreuzpointner, 1395
Krigar-Menzel, O., & F. Richarz, density of the earth, 1467; gravitational constant, 232
Křižik, F., electric semaphore, 1770
Krüger, T., 930
Krüger, M., electro-chemistry, 868; organic electro-chemistry, 489, 1406; organic electrolysis by alternating currents, 1943
Krüss, 244
Krüss, H., Fraunhofer's objectives, 1328
Kubierschky, M., surface-contact system, 1442
Kuenen, J. P., & W. G. Robson, mutual solubility, 1220
Kümmell, G., meteorological observations, 1126; migration constants, 148
Kundt, 426, 809
Kurlbaum, 671, 1362
Kurlbaum, F., radiating power of platinum black and lampblack, 808
Küster, 145

v. Laar, 149, 1056, 1202
v. Laar, J. J., dilution law, 850; heat of solution, 1544; heat of solution and solubility of electrolytes, 729
Lafay, A., polarisation of light, 1339; reflection of light, 991
Laffargue, J., transmission at Les Clées-Yverdon, 196
Lagrange, 18, 1521; fall of magnetisation in soft iron, 472
Lagrange, E., luminous electrolytes, 1178
Lahmeyer, 1572
Lander, G. D., & T. Purdie, optically active alkyloxypropionic acids, 1399
Landi, U., influence of moon on seismic movements, 1466
Landolt, 840
Lane, 1469
Lane, W. B., apparent colour, 1132
v. Lang, V., vibrations of caoutchouc strings, 1697
Langdon-Davies, 754
Langdon, W. E., intercommunication in trains, 746; power on the Midland railway, 203
Langhans, 1305
Langley, 21
Langley, J. W., Jacques cell, 583
Langley, S. P., bolometers, 54
Laplace, 18, 676
Laporte, F., photometric standards, 789
Larmor, 267, 1000, 1139
Larmor, J., electrostriction and electrodynamic equation of a moving material medium, 66
Larroque, F., theory of wind instruments, 1883
Larsen, 1242
Latrille, 290
Lauricella, G., propagation of heat, 58
Laurie, 849
Lauriol, P., electric traction, 213
Lawrence, R. R., mercury pump, 1835
Leathem, J. G., magneto-optic phenomena, 1139
Lebeau, P., glucinum, 150; production of beryllium, 335
Le Blanc, 302, 700
Leblanc, 505, 1583
Leblanc, M., compounding alternators, 908; compounding alternators for constant pressure, 620; induction generators, 500, 1271, 1429; parallel running of alternators, 1272
Lecher, 1903, 1904
Lecher, E., flexible spark discharges, 1709
Le Conte, J. N., harmonic analyser, 13
Leduc, 555, 1006, 1209
Leduc, A., atomic weights of oxygen and hydrogen, 1533; mechanical equivalent of heat and specific heats of gases, 261; molecular volumes, 1491; variation of γ with temperature, 260; velocity of sound, 811
Leduc, S., adjustable Leyden jars, 448; electric sparks, 451; Wimshurst machines, 447
Lee, A., & K. Pearson, Hertzian oscillator, 1169
Lee, C. A., & W. B. Burnie, conductivity of arc and oxides, 1504
Lees, C. H., thermal conductivity, 1147, 1148

Lefèvre, P., singular points in optical systems, 1130; Bravais points, 1850
Lehfeldt, R. A., dissociation of water, 725; liquid mixtures (part ii.), 61; vapour-pressure of solutions, 1746
Lehmann, 1392
Lehmann-Richter, E. W., arc-lamps, 1604
Leick, W., dielectric conduction, 298
Leiss, C., characteristics of crystals, 1651; quartz-spectrographs, 795
Lemke, H., damping of galvanometer needles, 823; Jena thermometers, 1361
Lemoine, J., & H. Abraham, Kerr phenomenon, 1859
Lenard, 818, 1704, 1887, 1898
v. Lengyel, B., photographic action of gases and metals, 256
Leon, 1403
Leonard, H. W., naval plant, 759
de Lépinay, J. M., C. Fabry, & A. Perot, measurement of length, 1112
Leslie, transformer tests, 1784; two-phase currents in New York, 1789
Letheule, E., effect of heat and moisture on dielectrics, 1026
Letheule, P., Bergmann arc-lamp, 954
Lewis, G. N., & T. W. Richards, zinc and cadmium amalgams, 1745
L'Hoest, M., illumination, 791
Liapounoff, 677
Lidoff, 146
Lieb, J. W., Jr., naval plant, 759
Liebenow, 309, 1743
Liebenow, C., dynamo testing, 1431; measurement of battery insulation, 1723; thermo-couples, 1516; thermo-electromotive forces, 1515
Liénard, polarisation of dielectrics, 1726
Liénard, A., theories of Lorenz and of Larmor, 267
Lincoln, A. T., & L. Kahlenberg, ionising power, 731
Lindeck, St., & W. Jaeger, manganin resistances, 110
Lindsay, 1109
Linebarger, 61, 136
Linker, 943
Lippich, 794
Lippmann, 5, 102, 271, 464
Lippmann, G., absolute measurement of time, 1463; maintenance of pendulum motion, 4
Lister, 718
Liveing, E., distribution of energy in gases, 809; ionisation, 860
Lloyd, 71
Lloyd, H., storage batteries and railways, 1810
Lloyd, R. McA., storage in traction stations, 1436
Löb, 1550
Löb, W., electrolytic synthesis, 1551
Lockyer, 987
Lockyer, N., spectrum analysis, 1484; spectrum of α Cygni, 986
Lockyer, W. J., 1886
Lodge, 105, 221, 1108, 1109, 1450, 1715
Lodge, O., absolute velocity and the ether, 653; space telegraphy and syntony, 960
v. Loenen-Martinet, M., accumulator traction, 626
Loewenthal, M., telephones, 1314
Lœwy & Puiseux, constitution of the moon, 1464; photography of the lunar surface, 17
Lombardi, L., condensers in alternate current transmission, 1585
Lommel, 1336
Long-Schattner, 603, 1955
Lönnqvist, E., benches for telegraph apparatus, 1826; relay-transmitters, 1107
Loomis, 1545, 1938
Loppé, F., correcting factor of watt-meter, 116
Lord, H. C., efficiency of spectroscopes, 1863
Lorentz, 1669, 1928
Lorentz, H. A., vibrations of charged ions in a magnetic field, 1668
Lorenz, 267
Love, E. F. J., Joule-Thomson effect, 1355
Low, G. P., accumulator at San Francisco Edison station, 925; Kootenay-Rossland power transmission, 1586; San Gabriel Los Angeles transmission plant, 923
Löwe, K. F., electric dispersion, 288
Lucius, 873
Lüdeling, G., magnetic disturbances, 1194; terrestrial magnetism, 71
Ludendorff, H., planetary theory, 1465
Lumière, A. & L., light at low temperatures, 1129; phosphorescence, 551
Lummer, O., & E. Pringsheim, specific heats of gases, 44; spectrum of a black body, 1482
Lundal, A. E., caoutchouc, 230
Lundell, R., generator with minimum field distortion, 1576
Lundie, J., rapid transit, 1289
del Lungo, C., density of liquids and vapours, 60
Lupke, 1949
Lussana, S., calorimetry, 1875; specific heat of gases, 43
Luther, 725
Luther, R., electrodes of the third kind, 864
Lutheroth, A., magnetisation of crystals, 323

Lyle, T. R., alternate-current problems, 317

Maarseveen, 1202
v. Maarseveen, G., & H. Goldschmidt, solubility, ionisation, and heat of solution, 1056
Macaluso, 246, 422, 424, 426, 545, 1340
Macaluso, D., & O. M. Corbino, light traversing metallic vapours in a magnetic field, 425, 427 ; radiation in a magnetic field, 792
MacArthur, 155
McCaw, G. T., bicycle-steering, 652
McClean, F., 1650 ; spectra of stars, 987
McClelland, J. A., conductivity of hot gases from flames, 100 ; inductoscripts, 996
McCulloch, R., single and double truck cars, 379
McGhie, J., electric power in mining, 904 ; electricity on vessels, 1570
MacGregor, 330
MacGregor, J. G., electrolysis, 1405
MacGregor, J. G., & E. H. Archibald, conductivity of double salts, 595
McGurty, 768
Mach, L., air jets, 8
Mache, H., gases under high E.M.F., 1160
Mache, H., & E. Haschek, pressure within the spark, 1891
Mache, H., and L. Boltzmann, Van der Waals' equation, 1493
MacIntosh, 481
McIntosh, D., migration constant of hydrogen, 147
Mack, E., influence of pressure on melting-point, 47
Mack, K., flow structures, 1462
McKay, F. C., electrolytic conductivity, 330
McKissick, A. F., induction generator tests, 184 ; phase transformer, 192
MacLean, G. V., velocity of electric waves, 1497
Maclean, M., strain, 1177
Maclean, M. Kelvin, & A. Galt, electrification of air, 1494
McMahon, P. V., City and South London Railway, 1810
McNeill, H. C., magnetic ore separators, 1951
Macrae, 235
Maey, E., amalgams of alkali-metals, 1536
Maffiotti, G. B., & F. Pescetto, monophase asynchronous motors, 912
Maier, M., Röntgen rays, 1870
Mailloux, C. O., traction, 1436
Mair, G. R., electric locomotive, 1810
Majorana, Q., contact and E.M.F., 1385
Malagoli, R., coherer-sparks, 458
Malagoli, R., & C. Bonacini, radiography, 433 ; Röntgen rays, 1352, 1353
Mallock, A., light plane mirrors, 1326
Mallory, F., and C. W. Waidner, mechanical equivalent of heat, 1366
Maltézos, C., beats of strings, 1884
Mandroux, private central telephone stations, 1999
Manley, J. J., & V. H. Veley, conductivity of nitric acid, 1171
Mannesmann, O., mechanical resistance of air, 404
Marage, vowel sounds, 63
Marchand, 1152
Marchant, E. W., & W. Duddell, alternate arcs, 829
Marchena, E. de, rotary converters, 506
Marcher, T., induction motors, 1276 ; polyphase distributing systems, 920
Marchis, L., temperature changes of glass and thermometer zero points, 1686 ; tempering of glass, 1490
Marchis, M. L., glass and temperature, 554
Marconi, 220, 222, 782, 963, 965, 1166
Marconi, G., wireless telegraphy, 1452
Margules, M., electrolytic solution, 329
Marks, 952
Marmier, 1755, 1756
Martens, F. F., bright bands by two gratings, 420 ; lighting of polarisation apparatus and saccharimeter, 794
Martienssen, H., measurement of small inductances, 467
Martinet, Loenen-, M. v., accumulator traction, 626
Martini, 845
Marx, 737
Marx, E., electric dispersion, 289
Mascart, E., & H. Benard, rotary power of sugar, 1401
Mather, T., & W. E. Ayrton, galvanometers, 703
Mathews, C. P., & W. H. Thompson, & J. E. Hilbish, the photometry of the enclosed alternating arc, 951
Mathews, C. P., photometric readings, 542
Mathias, 262, 721, 1689
Mathias, E., magnetic charts, 475 ; rectilinear diameters and the laws of corresponding states, 1878
Mattausch, J., fuse-wires for air-lines, 1958
Matthews, F. J. A., carbide works at Ingleton, 157 ; commutator design, 621
Matthiesson, 1505
Mauduit, 1811
Maurain, 1572

Maurain, C., energy dissipated in magnetisation, 129; magnetic screening, 130
Mavor, H. A., power in workshops, 1282
Maxham, L. M., Maxham third rail system, 371
Maxim, 1252
Maxim, H. M., electric vehicles and their relation to central stations, 902
Maxwell, 240, 269, 285, 322, 464, 676, 718, 784, 965, 1154, 1330, 1344, 1703, 1902, 1908, 1911
Mehlhorn, F., gases occluded by moist glass, 1046
Melde, 446
Melde, F., notes of high frequency, 810; tuning plates, 265
Melville, 759
Memmo, 878
Mendeléeff, D., oscillations of balances, 6
Menges, R.-E., regulation of motors, 186
Menschutkin, 1200
Mercadier, 1995
Merrill, J. F., conductivity of copper, 1387
Merritt, E., deflection of kathode rays, 455; mechanical illustration of energy apparently potential but really kinetic, 413
Merritt, E., & E. L. Nichols, photography of manometric flames, 65
Merritt, E., & O. M. Stewart, vapours from the carbon arc, 573
v. Merz, 1328
Meunier, J., & H. Couriot, incandescent filaments, 608
Mewes, R., electrochemical theory, III., 1213
Meyer, 407, 446, 593, 1885
Meyer, A., & F. Auerbach, contact resistance, 297
Meyer, G., drop electrodes, 734; surface tension of mercury, 229
Meyer, H., 1126
Meyer, O. E., 262
Meyer, S., 821; magnetic properties of inorganic compounds, 1922; magnetic properties of the elements, 1529
Meyer, S., & G. Jäger, magnetic susceptibility of water, 715, 836; susceptibility of liquids, 131
Meyerhoffer, 1010
Meyerhoffer, W., & A. P. Saunders, normal temperature, 1009
Meynier, A., charging for electrical energy, 387; utilisation of central station plant, 1437
Michelson, 25, 1338, 1666, 1673
Michelson, A. A., 1666, 1673; echelon spectroscope, 1678
Mie, G., motions of the ether, 1323
Mie, G., & E. Arnold, theory of commutation, 1084
Miethe, 244
Miller, L. B., wireless telegraphy, 1452
Miller, D. C., H. T. Eddy & E. W. Morley, velocity of light in a magnetic field, 1667
Miller, K. B., causes of cross talk, 1110; centralised sources of energy in telephone exchanges, 972; exchange improvements, 1457; "express" telephone system, 971; luminous signal boards, 393; telephone exchanges, 1311; telephone repeater, 637
Millis, 461
Milner, S. R., & A. P. Chattock, conductivity of water, 1356
Minet, A., impurities in aluminium, 1553
Minozzi, A., pyknometer, 1627
Mior, A., hydrogen and platinum, 844
Miot, E., moving platform railway, 1601
Mitchell, 1685
Mitchell, S. A., concave grating stellar spectroscope, 1864
Mixter, W. G., electrosynthesis, 1049; endothermic gases, 1389; explosive gases, 1390
Mohr, E. C. J., water—sal ammoniac—iron chloride system, 854
Moissan, H., applications of aluminium, 1532
Moldenke, R., melting-point of cast iron, 669
Möller, J., electrolytic carbamine, 1550
Monarch, 1951
Mond, L., W. Ramsay, & J. Shields, occlusion by palladium, 1204
Monoyer, vowel sounds, 64
Montel, B. L., high efficiency incandescent lamps, 1820; life of incandescent lamps, 953
Montillot, L., railway telephone, 974; telephone call dials, 395
Montlaur, 343, 873, 1239
Moon, W., capacity of wires, 270; the K.R. law, 1374
Moorby, W. H., & O. Reynolds, mechanical equivalent, 52
Moore, 1298
Moore, J. E., discharge streams, 1022
Morano, F., atmospheric tides, 1638; conductivity of rocks, 672
Mordey, W. M., 1573, 1782; electric traction, 935; induction motors, 1275
Moreau, 216
Moreland, S. T., of inductance, 696
Moritz, B., efficiency of electrolytic processes, 736
Morize, H., Röntgen radiation, 437
Morley, E. W., H. T. Eddy, & D. C. Miller, velocity of light in a magnetic field, 1667

Morten, 1610
Morton, W. B., oscillations along wires, 1168
Morton, W. B., & E. H. Barton, oscillatory discharge, 1379
Morton, W. J., therapeutic apparatus, 1189
Mossotti, 1908
Mouchel, C., hot pressing of cloth, 901
Moulun, G., motors for alternating currents, 752
Moureau, G., magnetic elements on January 1, 1899, 476; torsion and recalescence of steel, 538
Mourelo, J. R., fluorescent solutions, 1145; phosphorescence, 552
Moxham, A. T., wear of steel rails, 530
Mozley, H., tramcar design, 1291
Muirhead, 1108
Müller, 723, 1946
Muller, A., stellar spectra, 990
Müller, E., electrolytic chlorates, 1408
Müller, H., accumulator switch, 1247; three-phase synchronisers, 1774
Muller, T. P., dilution of electrolytes, 1230
Müller, P. A., 1194
Mueller-Erzbach, W., molecular forces, 774; vapour pressures, 142
Munro, G. W., traction-plant, 507
Munroe, C. E., explosions, 1388
Murani, O., Hertzian oscillations, 1905; radiography, 433
Murphy, 523, 1443
Murphy, E. J., Jr., & P. E. van Saun, Rushmore multi-circuit dynamo, 619
Murphy, W. J., conductor-resistance of cables, 294; detecting faults, 1174; Schaefer's break test, 295
Murray, E., wireless telegraphy, 1452

Naccari, A., diffusion through ferrocyanide membranes, 478; electric currents in dielectric liquids, 462
Nagaoka, H., & K. Honda, magnetostriction, 714
Nahnsen, 1757
Natanson, 1491
Natanson, L., variations of a system in motion, 1324
Neesen, F., pumps, 1461; Röntgen radiation, 1486
Negreano, D., dielectric constants, 1028; specific heat, 1149
Neidt, J., traction problems, 1101
Neldt, 757
Neovius, O., new atmospheric gas, 139
Nernst, 74, 102, 302, 341, 482, 581, 670, 728, 731, 734, 959, 1062, 1226, 1746
Nernst, W., electrolytic conductivity of solids, 1910; accumulators, 1743
Nernst, W., & E. Bose, osmotic theory of the galvanic cell, 863
Nernst-Ettinghausen, 822
Neugschwender, 820
Neugschwender, A., anti-coherer, 1380; wave detector, 567
Neumann, 302, 676, 677, 870
Neumann, E., reversible electrodes, 708
Neumann, F., 1685
Neville, F. H., & C. T. Heycock, Röntgen ray photography and alloys, 1394
Neyreneuf, irregular organ pipes, 1370
Nicholls, 21
Nichols, E. F., 1841
Nichols, E. L., density of ice, 397; expansion of ice, 1152
Nichols, E. L., & E. Merritt, photography of manometric flames, 65
Niethammer, 1572
Niethammer, F., hysteresis, 835
de Nikolaieve, W., disruptive discharge, 1889; magnetic field within a tubular current, 1923
Noark, 1559
Nodon, 1082
Noë, de la, 244
Noë & A. Bemond, Röntgen rays, 432
Northey, P., motor cars, 1294
Noyes, 729, 850, 1057, 1544
Noyes, A. A., heat of solution, ionisation, and solubility, 730; ionisation, 149; osmotic work, 1223; solubility of a binary electrolyte, 851
Noyes, A. A., & D. Schwartz, solubility of salts, 724
Noyes, A. A., & E. S. Chapin, binary electrolyte, 1231
Noyes, A. A., & G. J. Cottle, reaction velocity, 1199

Oberbeck, 1911
Oberbeck, A., discharges, 681; induction coil, 121; volumenometer, 405
Obermayer, air waves, 9
Oddone, E., atmospheric potential, 1705
Oersted, 676
Oettel, 341, 1239, 1760, 1946
Ogg, A., equilibrium between amalgams and solutions, 852
O'Gorman, M., telephone system in Paris, 223; wiring, 748, 1959; wireless telegraphy, 1452
O'Gorman & Cozens-Hardy, paper telephone cables, 1455
Olsen, H., grating-spectroscope, 660
O'Neal, E. A., & J. L. Howe, electrolytic formation of alums, 735
Onimus, illumination measurement, 241
Oppenheimer, S., Faraday effect, 658
Oppermann, motor car cells, 1294
Orr, W. McF., precession, &c., 414
Osmond, F., iron and nickel, 1203; magnet steels, 1524; temperatures and magnetic properties, 1525

Ossanna, G., induction motors, 1781
Ostwald, 149, 326, 840, 860, 1056, 1057, 1058, 1214; accumulators, 1743; electrolytic evolution of H., 1941
Otto & H. Strecker, production of metallic oxides, 337
Oudin, electric resonators, 92
Outerbridge, 1395
Outhenin Chalandre, 873

Paalhorn, 804
Paalzoid, 99
Paine, E. B., & H. E. Gough, transformer for 150,000 volts, 188
Palazzo, L., magnetic instruments, 1932
Palmaer, 734
Palmaer, W., drop electrodes, 1226
Palmer, Jr., A. de F., high-pressure piezometer, 983
Pandolfi, M., & A. Battelli, water optically uniform, 1653
Pandolfi, M., & V. Boccara, dielectromagnetic media, 1528
Panichi, U., influence of stress on capacity, 271
Papanti, L., barometric determination of height, 1637
Parker, 873
Parker, T. H., motor car design, 1296
Parshall, 935, 1574, 1782
Parshall, H. F., electric traction, 937
Parshall, H. F., & H. M. Hobart, electric generators, 910; physical properties of metals, 981
Parvillee, 903
Paschen, 102, 1017, 1482
Paschen, F., spectrum of a black body, 1348
Paschen, F., & H. Wanner, emission function, 1138
Pasquini, 1905
Patten, F. J., electric engraving machine, 1966; electric furnaces, 879; special alternators, 1778; telautograph with rotary-field drive, 1824
Patterson, 109
Patterson, G. W., measurement of self-induction, 1911
Patterson, G. W., Jr., & K. E. Guthe, electrochemical equivalent of silver, 1727
Pauli, H., Siemens and Halske process, 155
Pausert, T., Thomson-Houston enclosed lamp, 1105
Paweck, H., electrolytic estimation of zinc, 1750
Peake, A. H., & W. H. Everett, effect of commutation on field, 751
Pearson, F. S., the developments in conduit railways, 1810
Pearson, K., & A. Lee, Hertzian oscillator, 1169
Pearson, K., & H. J. Tomlinson, continuous beams, 493
Peck, J. S., transformer equipment of Carborundum Company, 916
Pellat, 303, 1184, 1727; sunsets, 1646
Pellat, H., atmospheric potential, 1706; discharge by evaporation, 562; energy of magnetic field, 561; energy of magnetic fluid, 318; loss of charge by evaporation, 1375, 1888; polarisation, 1158, 1159; Wehnelt interrupter, 1031
Pellat, H., & P. Sacerdote, dielectric constants and temperature, 463
Pellin, P., & A. Broca, spectroscope of fixed deviation, 1480, 1865
Pellissier, G., accumulators, 601; charging for electrical energy, 949
Peloux, 1420
Peltier, 1516, 1704
Peniakoff, 598
Penniman, T. D., & H. A. Rowland, measurements with alternating currents, 1724
Perkin, 658
Perkins, F. B., inspection of car equipments, 377
Perot, 250, 690
Perot, A., & C. Fabry, absolute electrometer, 315; electrostatic voltmeter, 586; fringes of high order, 24; interference applied to metrology, 1643; interferential measurement, 980; monochromatic light, 1470; order of fringes, 25; spectra, 1143
Perot, A. J., M. de Lépinay, & C. Fabry, measurement of length, 1112
Perrin, 859, 1898
Perrot, L., thermo-electromotive forces, 104
Péscetto, F., & G. B. Maffiotti, monophase asynchronous motors, 912
Petavel, J. E., emissivity of platinum, 1017
Peters, F., sugar refining, 739
Petersen, E., 1557; primary batteries, 1067
Petroff, 1596
Petrovitch, M., electrical oscillations in variable circuits, 1714
Petrovsky, A. A., & I. I. Borgmann, capacity, 1501; measuring capacities, 1029
Pettinelli, P., Röntgen rays, 663
Petzholdt, 1152
Peukert, W., measuring high electric pressures, 694
Pfaff, 300
Pfatischer, 492
Pfaundler, L., specific heat, 665
Pflüger, 1708
Philip, A., shunt dynamos in parallel, 501

Philipps, 873
Phillips, C. E. S., 1710, 1902; vacuum tubes, 683
Pickering, 987
Pictet, 157
Pidgeon, W. R., influence machine, 1915
Pigg, J., wiring rules, 747
Pinter, J., photographic receiver for cable signals, 1825
Pio, C., rotary converters, 1582
Pitcher, F. H., temperature and magnetisation on iron, 1522
Pizzarello, A., cohesion of mercurial columns, 401
Pizzetti, P., gravity, 1125
Planck, 302, 1059
Planck, M., irreversible radiation, 268; irreversible radiation processes, 1701
Platania, 1387
Platania, G., & G. P. Grimaldi, polarisation of metallic foil, 580
Platner, G., dissociation and thermochemistry, 1398; galvanic cells, 862; neutralisation, 1214
Plücker, 1152
Pochettino, A., acoustic resonators, 1699; dissociation of N_2O_4, 846, 1539
Pockels, 1857
Pockels, A., surface tensions, 645
Pocklington, H. C., conditions of sensitiveness of the thermopile and bolometer, 1876
Poincaré, 677, 690
Poincaré, A., lunar influence on barometric charts, 1640
Poincaré, H., magnetic energy, 1154; solar system, 18; Zeeman effect and theory of Lorentz, 1669
Poiseuille, 1623
Poisson, 18, 676, 1908
Poisson, G., liquid waves, 409
Pollak, 917, 1090
Pollock, J. A., & R. Threlfall, gravity balance, 1630
Pollok, J. H., thermal effects of dilution, 1396
Pomey, J. B., electrostatic capacity of two parallel wires, 1707; low resistances, 1176; networks of conductors of finite transverse dimensions, 1703; Thévinin's theorem, 1025
Ponsot, A., osmotic pressure, 1540
Pontifex, B., electricity on torpedo vessels, 531
Poole, C. P., dynamo design, 618
Pope, W. J., triboluminescence, 1680
Porter, T. C., Newton's rings, 238
Post, W. A., electric crane, 1261
Postal-Vinay, 1600
Potier, 1727; polarised dielectrics, 1908
Potier, A., armature reaction, 1571
Potter, 935
Potter, W. B., 939
Pottevin, H., rotatory power, 1856
Poucelet, 1354
Poynting, 1323, 1715
Poynting, J. H., & P. L. Gray, directive action of one crystal on another, 777
Pratt, 1421
Precht, J., deflection of discharges, 277; electric discharge, 1021; Hertz, experiments, 286
Preece, 1450
Preece, A. H., electricity supply of London, 1795
Preece, W. H., magnetic space telegraphy, 962; mining, 921
Prelinger, 1948
Preston, T., magneto-optic phenomena, 1479; radiation in a magnetic field, 1000
Prevost, J. L., & F. Battelli, physiological action of currents, 651
Pribram, 1856
Pringsheim, E., interference microscope, 995
Pringsheim, E., & O. Lummer, specific heats of gases, 44; spectrum of a black body, 1482
Privat, 1596
Proctor, H. F., auxiliary plant at Bristol, 200
del Proposto, C., regulation in three-wire systems, 623
Prout, 1898
Provostaye, 1339
Puiseux & Lœwy, constitution of the moon, 1464; photography of the lunar surface, 17
Pulfrich, 1471
Pulfrich, C., instruments for crystallography, 1331; interference apparatus, 3
Puluj, 775
Pupin, M. I., long electrical waves, 1381
Purdie, T., & G. D. Lander, optically active alkyloxypropionic acids, 1399

Quin, electricity works, 1798
Quincke, 227, 228, 471, 715, 1885

Rabbridge, P., telephone indicators, 392
Ramage, H., & W. N. Hartley, gallium in the sun, 1840
Ramsay, 593, 727, 1222, 1747
Ramsay, W., new gases, 1207; recently discovered gases, 841
Ramsay, W., L. Mond, & J. Shields, occlusion by palladium, 1204
Raoult, 136, 1055
Raoult, F. M., cryoscopy, 858
Raphael, C., telephone systems, 224
Raps, 1696

Raveau, M., red sunset, 1646
Ravenshaw, W. H., mining, 921
Raworth, J. S., wiring rules, 748
Rayleigh, 109, 237, 240, 284, 419, 1137, 1161, 1209, 1852, 1911 ; anomalous dispersion, 1344 ; conduction of heat, 1359 ; propagation of sound, 1371 ; transmission of light through an atmosphere containing small particles in suspension, 1655
Raymond-Barker, 826
Raymond, H. E., Kingston (Jamaica) electric tramways, 1805 ; lightning arresters, 605, 887, 1956
Reed, C. J., thermoelectric and galvanic action, 309, 701
Reed, L. C., differential rate meter, 1562 ; meter practice, 895
Reese, H. M., & H. C. Jones, conductivity of praseodymium and neodymium sulphates, 328
Regnault, 257, 261, 1008, 1209, 1879
Reid, T., early traction history, 1810
Remond, A., & Noë, Röntgen rays, 432
Reynolds, E., 1335
Reynolds, O., slipperiness of ice, 1322
Reynolds, O., & W. H. Moorby, mechanical equivalent, 52
Reyval, J., accumulators, 600 ; Aron energy-meter, 1954 ; "Fortis" material for high tension lines, 894 ; heating apparatus, 743 ; motor-cars, 384, 1246 ; Parvillee electric heating apparatus, 903
Rhoads, E., iron in a magnetic field, 321
Rhodes, W. G., alternate current motors, 1089 ; alternating current problems, 122
Rhodin, 598, 1242
della Riccia, study of shunt-wound dynamo, 749 ; wireless telegraphy, 963
Ricco, A., gravity near Etna, 15
Rice, A. L., armature windings, 180, 503 ; drum armature windings, 352
Richard, 896
Richard, G., applications of electricity, 744, 1250, 1769 ; arc lamps, 958, 1449 ; cranes and elevators, 1423 ; electric furnaces, 878
Richards, H. T., call register, 1615
Richards, J. W., Jacques cell, 701
Richards, T. W., retention of gases by metallic oxides, 593 ; spectra of hydrogen, 1345 ; temperature coefficient of the potential of the calomel electrode, 581
Richards, T. W., & G. N. Lewis, zinc and cadmium amalgams, 1745
Richards, T. W., & J. B. Churchill, thermometric fixed points, 1010
Richards, T. W., & W. L. Harrington, boiling-points of mixed solutions, 1053
Richardson, 873, 1242
Richarz, 1521
Richarz, F., Dulong and Petit's law, 1363 ; kinetic theory of gases, 1013
Richarz, F., & O. Krigar-Menzel, density of the earth, 1467 ; gravitational constant, 232
Riche Preller, C. du, Lausanne tramways, 927
Rider, J. H., combined lighting and traction works, 1798
Ridley, A. E. B., electric elevators, 1078
Riecke, 300, 702
Riecke, E., electrothermal relations, 299, 1024 ; kathode rays, 283 ; pressure in radiometers, 1853 ; work consumed in a spark-gap, 1892
Righi, 220, 422, 793, 965
Righi, A., absorption of light, 1476 ; absorption in a magnetic field, 421 ; improved Lecher system, 1904 ; inverse Zeeman effect, 424 ; Zeeman effect, 1341 ; Zeeman phenomenon, 423
v. Rijckevorsel, meteorological and magnetic phenomena, 838
Riker, 601
Rimbach, E., estimation of cadmium, 871 ; rotatory power of electrolytes, 997
Ritter, 757
Ritter, G., telephone exchange system, 1616
Ritter, R. B., alternate-current radiators, 1071 ; electrical heating, 171 ; power transmission at Granada, 766 ; rotary converters, 1435
Rive, de la, 690
Robb, rotary transformers and storage with long-distance transmission, 1794 ; transformer tests, 1784
Roberts, 873, 878, 1244, 1423
Roberts, E. P., economy in electric light stations, 510
Roberts-Austen, 49, 848
Roberts-Austen, W. C., surfusion of metals and alloys, 46
Robertson, G. H., electrolytic soda and bleach by Solway process, 1758
Robinson, 873
Robson, W. G., & J. P. Kuenen, mutual solubility, 1220
Rodewald, H., gelatinisation of starch, 327
Rogers, 109
Rogers, A. J., carbon-consuming batteries, 1034
Roget, S. R., magnetic properties of iron, 590
Rohde, A., electrolytic reduction, 1236
Rohr, M. von, distribution of light on the focal plane of a photographic objective, 244

Rohr, W., magnetic properties of iron, 712
Rolf, 873
Roller, F. W., electrical apparatus on battleships, 1076
Roloff, M., physical effects of light, 140
Rongo, E., copper deposition, 738
Rood, 28
Rood, O. N., flicker photometer, 26, 27
Roozeboom, Bakkuis-, 854, 1220, 1402; solidification, 1221; solubility and melting-point, 1210
Rosa, E. B., equations of a plane electromagnetic wave, 1665
Rosa, E. B., & A. W. Smith, condenser losses, 588, 589
Rose-Innes, 1355
Rose-Innes, J., and S. Young, thermal properties of normal pentane, 1688
Rosenbaum, 1242
Rosenberg, E., slip of induction motors, 1780
Rosenblum-Yarnold, 598
Rosencrans, W. H., permanent way, 1290
Rosenhain, W., & J. A. Ewing, structure of metals, 1196
Rosenheim, O., & P. Schidrowitz, optical activity of gallotannic acid, 1400
Rosenthal, H., optical properties of minerals, 1848
Ross, B. A., arc lamps, 956
Rostin, 1757
Rota, A., capillary angles, 400
Rotch, 1642
Rothe, R., thermostat, 1690
Rothmund, 1202
Routh, 414
Routin, 745, 1431, 1765
Rovida, A., monochromatic light, 1336
Rowland, 109, 267, 1309, 1366, 1704, 1862
Rowland, H. A., & T. D. Penniman, measurements with alternating currents, 1724
le Roy, A., Wehnelt interrupter, 1517
le Royer, 1336
Rubens, 99, 690
Rubens, H., & E. Aschkinass, heat-waves, 553; infra-red absorption, 21
Rubens, H., & E. Hagen, metallic reflection, 992
Rücker, 1702
Rudeloff, M., mechanical properties of copper, 772
Rudolphi, 149
Runge, C., argon spectrum, 1861
Rushmore, 619
Russell, 339, 1065, 1681
Rutherford, 251, 1679
Rutherford, E., uranium radiation, 1001
Ruud, E., gas engines 1260
Rymer-Jones, J., siphon-recorder signals, 1106
van Rysselberghe, 1453, 1831

Sacerdote, 1006, 1209
Sacerdote, P., deformation of dielectrics, 1907; mixture of gases, 1695
Sacerdote, P., & H. Pellat, dielectric constants and temperature, 463
Sachs, J., accurate fuses, 1559
Sagnac, 1352
Sagnac, G., magnetic pyrites, 1930; Röntgen rays, 546, 547; secondary radiation, 34; transformation of Röntgen rays, 1005
Sahulka, J., electric arc, 103; transformer and rectifier for polyphase currents, 505
Salcher, R. M., & H. Goldschmidt, organic bases in aniline, 1535
Salkowski, H., & W. Hittorf, new class of inorganic acids, 1404
Salomon, E., residual current, 1052
Salvador & H. Bordier, electrolytic actions near Crookes tubes, 1496
Salvadori, R., concentration cells, 1729
Sande Bakhuyzen, E. F. v. de, movement of terrestrial pole, 1645
Sandrucci, A., residual phenomena in Crookes tubes, 817
Sanford, 1387
Sankey, 178
Sarasin, 690
Sarran, 807
Sartiaux, E., & Aliamet, Leblanc rectifiers, 1583
Satori, Wehnelt interrupter, 1517
van Saun, P. E., & E. J. Murphy, Jr., multi-circuit dynamo, 619
Saunders, 1010
Saunders, A. P., & W. Meyerhoffer, normal temperature, 1009
Saurel, P., electrostatic theorems, 1373; equilibrium of a one-component system, 1537; Maxwell's theorem, 1492; phase rule, 1217, 1218
Sauveur, 1395
Sawyers, 1423
Schaefer, 295
Schall, C., electrolysis of benzoic acid, 1753
Schall, C., & R. Klein, electrolytic nitro-benzene, 866
Schall, C., & S. Kraszler, electrolytic dithio-disulphides, 867
Schattner, 603, 1955
Schaufelberger, W., dielectric polarisation, 1027
Schaum, K., concentration cells, 1227
Scheel, K., measurement of temperature and pressure, 1874
Scheiner 233, 988
Schenck, 1392

Schidrowitz, P., & O. Rosenheim, optical activity of gallotannic acid, 1400
Schiemann, M., Bommern-Witten tramway, 1981 ; magnetic cut-out, 1418
Schiller, N., osmotic pressure, 722
Schleiermacher, 1017
Schlesinger, F., stellar radial velocities, 1647
Schluckebier, wireless telegraphy, 222
Schmidt, G. C., photoelectric currents, 1212 ; polarised fluorescence, 1869
Schmidt, G. C., & E. Wiedemann, potential gradients in vacuum tubes, 280
Schoeller, A., electrolytic formation of amalgams, 1062
Schoenbein, 1949
Scholl, H., daguerreotype as an interference process, 1474
Schollmeyer, 739
Schonau, W., & A. Jordan, test to faults, 1030
Schönrock, 658
Schoop, M., accumulator tests, 1416
Schoop, P., & H. Benndorf, accumulator tests, 1068
Schrader, 1059, 1405
Schreber, K., absolute temperature, 1015 ; dimensions of electrical units, 1702 ; osmotic wind, 1225
Schreihage, 952
Schreinemakers, F. A. H., water—alcohol—succinonitrile system, 853
Schröder, L., accumulators for traction, 1286
Schüler, 1774
Schulze, 1369
Schulze, F. A., conductivity of solids, 803 ; high pitches, 1885 ; pitches of Appunn pipes, 1368
Schumann, 546
Schürr, J., measurement of high resistances, 576
Schuster, 109, 282, 1366, 1475
Schuster, A., & G. Hemsalech, constitution of electric spark, 1377
Schwalbe, G., annual magnetic variation, 1038
Schwartz, D., & A. A. Noyes, solubility of salts, 724
Schwarz, B., & K. Elbs, reduction of m-nitro-p-toluidine, 336
Schwecke, H. C., & W. Graetz, bichromate cells, 307
Schweidler, E. R. v., flame-electrodes and dropping-electrodes, 303
Scott, A. M., polarisation capacities, 579
Scott, A. P., & H. T. Barnes, solution densities, 398
Scott, E. K., high-speed rotary converters, 1787 ; improvements in brush alternators, 1777 ; over-compounding dynamos, 1973 ; three-phase currents for traction, 936 ; traction, 935 ; transformer cores, 1782
Scott, F., power transmission, 764
Scott, J. G., power for electric traction, 1809
Scribner, 1313
Scripture, E. W., colour-weakness and colour-blindness, 1663
Secchi, 987
Seckelson, E., magnetic susceptibilities, 471
Sedgwick, W., predictions of Neon, 718
See, T. J. J., sun's heat, 1469
Seefehluer, E. E., investigating alternating currents, 1512
Segre, E., manufacture of calcium carbide, 1412
Séguy, G., variation of gaseous pressure in vacuum tubes, 80
Seidel, O., 1548
Selden, C., simultaneous telegraphy and telephony, 1831
Sella, A., radiophony, 558 ; telephone experiments, 559
Sellmeier, 237, 1672
Sengel, A., subdivision of dynamo E.M.F., 1263
Serpollet, 759
Serrell, L. W., building an electric railway, 1810
Setzval, 244
Seubert, 840
Seymour, 1592
Shakespear, G. A., Young's modulus by interference method, 1618
Shand, 1421
Sharpe, B. F., measurement of sound, 1696
Sharpstein, S. H., switchboards, 1072
Shaw, W. N., Dalton's law, 257
Shaw, Hele-, H.S., fluid motion, 978
Shedd, J. C., Carnot's engine, 1367 ; incandescent lamps, 98
Sheldon, S., & G. M. Downing, magnetic effect of electrolytic currents, 305
Shepardson, G. D., potential round commutators, 316
Sherman, 1817
Sherman, S. S., & T. B. Booth, American motor cars, 1817
Sherwood, J. H., power in workshops, 1281
Shields, 1747
Shields, J., W. Ramsay, & L. Mond, occlusion by palladium, 1204
Sickles, E. C., & R. C. Carpenter, flow of steam through pipes, 1428
Sieg, accumulator traction, 1593
Siemens, 155, 342, 370, 604, 623, 878, 892, 1423, 1757
Siemens, A., electrical machinery on board ship, 1963 ; transmission of energy, 201 ; mining, 921

v. Sigmond, A., hydrolysis, 1198
Silbermann, 1875
Simon, 1918
Simon, H. T., Wehnelt interrupter, 1520, 1919
Sinclair, A., 1596
Sirks, 995
Sissingh, 1139
Skinner, 1507
Skinner, C. A., potential gradient at the anode, 1901
Skinner, S., & J. J. Thomson, kathode rays, 84
Sklodowska-Curie, *see* Curie
Slaby, 222
Slight, 244
Smart, 1991
Smee, 339
Smith, A. W., & E. B. Rosa, condenser losses, 588, 589
Smith, E. F., 1751
Smith, E. F., & D. L. Wallace, determination of uranium and cadmium, 338
Smith, J. H., short-circuited secondary coil, 461
Smith, J. M., storage in traction, 1436
Smith, S. W. J., electro-capillary phenomena, 821
Smith, W. A., ionisation of acids, 1057
Smith, W. R., 1993
Smithells, A., H. M. Dawson, & H. A. Wilson, conductivity of flames, 574
Snell, 179; electricity works, 1798
Snell, J. F., three-component system, 483
Snell, J. F. C., condensers for electric stations, 1773
Snow, W. B., mechanical draft, 350
Sohncke, 1704, 1869
Sohncke, L., variation of specific heat, 802
Sollas, W. J., structure of crystals, 144
Solomon, M., temperature coefficients of the standards for the 1897 ohm, 314
Sommerfeld, A., electromagnetic waves, 570
Soret, 1949
Spadavecchia, G., magnetism and the thermoelectric properties of bismuth, 1931
Spagnuolo, V., polyphase distribution, 360
Speed, B., self-correcting photometer, 1659
Spencer, T., telephone engineering, 1608
Speyers, C. L., molecular weights, 136
Spies, P., & A. Wehnelt, Wehnelt interrupter, 1521
Spitaler, 1126
Spitzer, O., production of leading currents, 1731
Sprague, 1423
Sprague, F. J., multiple unit system for electric railways, 1810
Sprung, A., height of clouds, 1639
Stäckel, P., central motions, 1121
Staigmüller, 1013
Stanley, 1766
Stansfield, A., thermoelectric pyrometry, 49
Stark, J., coagulation of colloid solutions, 1741; gaseous conduction in incandescent lamps, 1894; intermediate conductors, 301; liquid films, 10; pseudo-precipitation, 1740
Starke, H., 288; kathode rays, 87; refractometer, 1332; Röntgen rays and spark discharges, 252
Starkweather, G. P., Regnault's calorie, 1008
Stas, 1209
Stead, J. E., 137; alloys, 716
Stefan, 723, 808
Stefanini, A., & A. Battelli, freezing- and boiling-points, 1055
Steiger, A., mining, 921
Stein, 810
Steinheil, R., chromatic and spherical aberration in astronomical telescopes, 1846
Steinmetz, 367, 1421.
Steinmetz, C. P., 1575, 1582; dielectric strength of air, 77; lightning discharges, 73; rotary converters, 758
Stekloff, 58
Stekloff, W., Dirichlet's principle, 677
Stendebach, 943
Stephenson, C. A., wireless telegraphy, 1452
Sterneck, 15
Stern, G., polyphase distribution, 1584
Stevens, J. S., measurement of the changes produced in metals by magnetisation, 135; molecular contact, 403
Stewart, O. M., & E. Merritt, vapours from the carbon arc, 573
Stewart, W., incandescent wires, 7
Stine, W. M., ammonium - chloride accumulator, 160; Amyl acetate standard lamp, 1662; hysteresis in instruments, 1036
Stobrawa, bow form of trolley, 374
Stöckle, J., surface tension of H_g, 228
Stoermer, 737, 1242
Stokes, 237, 978, 1120, 1133
Stone, I., 972
Stone, J. P., armature windings, 502; multiphase armatures, 182
Stoney, 1000, 1162
Straneo, P., conductivities, 56; temperatures of linear conductors, 51, 443; thermal conductivity of ice, 1685; thermodynamic equivalence in a bimetallic conductor, 773

Strasser, 309
Straub, 873
Straubel, R., elasticity of glass, 1620; monochromatic illumination, 245; prismatic images, 243
Strecker, 222
Strecker, H., & Otto, production of metallic oxides, 337
Strehl, K., microscope, 1137
Strouhal, 132
Strub, 933
Struve, 1152
Stscheglayew, J., hydrophane, 22
Stumpf, C., 446, 1885; determination of pitches, 1369
Sturm, 1714
le Sueur, 873
Sullivan, 1730
Sullivan, E. C., iodine compounds, 1397
Sumee, J. K., dynamo design, 179
Summers, B. S., cast-iron and steel, 1526
Sundorph, T., action of coherers, 1717; conductivity of lead peroxide, 1912
Sundström, 137
Sutherland, W., latent heat of evaporation of zinc and cadmium, 45; Röntgen rays, 1162
Svedelius, G. E., length-variation during recalescence, 1
Svilokossitch, electrostatic voltmeter, 117
Swinburne, J., 598; Nernst electric lamp, 959; short distance power distribution, 1793; traction, 935
Swinton, A. A. C., circulation of gaseous matter in Crookes tubes, 82; kathode rays, 687; luminosity of the rare earths, 1683; Wehnelt interrupter, 1517; wireless telegraphy, 1452
Switzer, J. A., curve tracer, 14
Swyngedauw, R., discharge of a Leyden jar, 79; secondary discharge, 75
de Szily, C., effect of torsion on electrical resistance of alloys, 1721

Tammann, G., 1047, 1197, 1202, 1936; crystallisation, 326; crystallisation-velocity, II., 145; heat of fusion, 1150; limits of the solid state, 1693; vapour pressure of hydrates, 720; viscosity of liquids, 1111
Tammann, G., & A. Bogojawlensky, electrolytic conduction, 733
Tanakadate, 1572
Taylor, 1170, 1505, 1697
Taylor, B., municipal ownership of tramways, 1810
Taylor, J. E., electrical radiation, 1715
Taylor, S. N., Clark and cadmium cells, 582
Taylor, W. W., cryoscopic measurements, 856
Teichmüller, J., measurement of P.D., 1180
Tereschin, 288
Terry, H. L., vulcanised indiarubber, 1534
Tesla, N., 274, 1033, 1499, 1769; discharge phenomena, 682; high-frequency experiments, 1383; oscillators for therapeutic purposes, 287
Thayer, E. F., boiling-point curves, 667
Thayer, G. L., design of secondary circuits, 918
Thévenin, 1025
Thiesen, M., pressure of water vapour below zero, 806
Thiesen, A. H., effect of temperature on hysteresis, 1736
Thiessen, A. M., hysteresis, 834
Thomas, G. E., sodium pertungstate, 1238
Thompson, 1403, 1421
Thompson, J. F., breakage of axles, 1299
Thompson, J. O., period of a vibrating wire, 1118
Thompson, M. K., Jr., & H. M. Goodwin, electric properties of ammonia. 465
Thompson, S. P., 454, 942, 1109; Phillips' phenomenon, 1710; rotary converters, 757; wireless telegraphy, 1452
Thompson, S. P., & M. Walker, surface contact system, 217
Thompson, T. P., R. M. Klein, & F. Bedell, transformer plates, 622
Thompson, W. H., C. P. Mathews, & J. E. Hilbish, the photometry of the enclosed alternating arc, 951
Thomsen, 1209
Thomsen, J., 718
Thomson, 326, 1065, 1392, 1515, 1516, 1561
Thomson, E., 945, 1971; electricity on board ship, 759; Wehnelt's interrupter, 1181, 1517
Thomson, J. J., 288, 785, 818, 1715; charge carried by Röntgen ions, 1679; conduction in gases, 1156; conductivity of gases exposed to discharge rays, 1895; ionisation, 859; Lenard rays, 1162; motion of a charged ion in a magnetic field, 1896
Thomson, J. J., & S. Skinner, kathode rays, 84
Thomson-Houston, 1423
Thonet, C., rail bonding, 1441
Threlfall, R., electro-metallurgy, 597
Threlfall, R., & J. A. Pollock, gravity balance, 1630
Thwaite, 616, 1258
Thwaite, B. H., electric and steam traction, 1594

Tietz, M., Hertz telegraphy, 220
Tilden, W. A., specific heats, 42
Tindall-Schnelle, 598
Tissot, wireless telegraphy, 1606
Toepler, M., gliding sparks on glass, 279; brush discharge, 276
Tollenaar, D. F., kathode rays, 686
Tomlinson, 640
Tomlinson, H. J., & K. Pearson, continuous beams, 493
Tommasi, D., electrolysis of hydrochloric acid, 1945; electrolysis of water, 1063
Tommasina, T., coherers, 692, 1023, 1165, 1718; magnetic decoherer, 1166
de la Touanne, G., telephone exchange in Paris, 1456
Tower, 1775
Traube, 1747
Treves, Z., muscular action, 412
Trevor, 1057
Trevor, J. E., concentration cells, 1228
Tribelhorn, A., new method of accumulator construction, 1762
Trotter, A. P., & P. Cardew, electric tramways, 212
Trouton, F. T., electrolysis away from electrodes, 1942; flow of electrolytes, 1909
Trowbridge, 1162, 1345
Trowbridge, J., air under electric stress, 281; electrical discharges, 563
Trowbridge, J., & J. E. Burbank, absorption of Röntgen rays, 1487
Trudeau, 1427
Trustedt, 1411
Tudor, 706
Turner, M. E., cost of electrical energy, 386
Turpain, A., 1108; Hertzian field, 91; Hertzian field in air and in water, 569; Hertz resonator, 691; resonator with gap, 1382; wireless telegraphy, 964
Tutton, A. E., expansion of nickel and cobalt, 1488
Tyndall, 1852

Uebelacker, C. F., selection of rolling-stock, 1810
Ulsch, K., electrolysis of cane-sugar, 1549
Unwin, 1428
Uppenborn, 1609

v. der Vaals, 1153
Vallée, A., wiring calculations, 1566
Vallier, E., interpretation of a limited number of results, 649
Vandevyver, linear expansion, 442
Vautier, 555, 811, 1632
Vautin, 1242
Veley, V. H., & J. J. Manley, conductivity of nitric acid, 1171
Venske, 440
Verley, 1409
Verneuil, 552
Verwer, 1751
Vicentini, 1635
Vieille, P., deformation of waves, 1632; velocity of propagation of discontinuities, 266
Vigreux, C., & L. Brillié, differential arc lamp, 1447
Villard, P., Crookes tubes, 438; kathode rays, 85, 86, 454; Röntgen rays, 1144; Röntgen ray screens, 430; Wehnelt interrupter, 1517
Villari, E., cooling effect of gases traversed by electric discharge, 816; Röntgen rays, 435; Röntgen ray shadows, 434
Vincent, J. H., Colson-Russell photographic effect, 1681; dispersion model, 1854
Viola, C., optical constants of a crystal, 1652
Violle, 811, 1017, 1632
Violle, J., velocity of sound in air, 555
Vogel, 233, 244, 987, 1648
Vogel, H. C., velocity of α Aquilæ, 988
Vogelsang, 598
Voigt, 999, 1134
Voigt, W., 1694; broadening and reversal of spectrum lines, 1671; deformation in calcareous spar, 1122; effect of medium upon wave form of light, 1670; electrothermal relations, 822; kinetic theory of liquids, 1365, 1882; Kirchhoff's law, 1016; magneto-optic theory, 1140; optical properties in an electric field, 1857; pyroelectricity, 300; sodium in magnetic field, 1343; total reflection, 418, 1330; Zeeman effect, 1478; Zeeman components, 1858; Zeeman's and Faraday's phenomena, 1342
Voigt, W., & L. Januszkiewicz, homogeneous deformation, 639
Voigtlander, 723
Voisenat, J., 1997; induction telegraphy, 1450
Volkmann, P., Newton's third law, 231; surface tension of water, 227
Voller, A., & B. Walter, Wehnelt's interrupter, 1728
Volta, A., Röntgen rays, 436
Votoček, E., & E. Zenišek, organic substitution products, 1552
Vulcain, 1419
van der Waals,, 262, 326, 666, 807, 1209, 1222, 1320, 1493

Waddell, J., freezing-points, 1216; reversible reactions, 1051

Wade, E. B. H., aqueous solutions, 1211 ; platinum thermometry, 1012
Wadsworth, 1480
Waggener, 670
Wagner, earth returns, 1984
Wagner, H. A., 1279 ; distribution, 197 ; electric company of St. Louis, 205
Wagner, J., liquid volumes, 1113
Waidner, C. W., & F. Mallory, mechanical equivalent of heat, 1366
Waitz, K., electromagnetic waves, 290
Walker, 1051
Walker, G. W., Phillips' phenomenon, 1902
Walker, J., interference experiments, 1337 ; orientation of the slit in interference experiments, 419
Walker, M., Thompson-Walker surface contact system, 942
Walker, M., & S. P. Thompson, surface contact system, 217
Wallace, 1065
Wallace, D. L., & E. F. Smith, 1751 ; determination of uranium and cadmium, 338
Wallbott, H., reflection at mercury surfaces, 1654 ; surface tension, 1622
van der Wallen, M., traction on canals, 617
Wallerant, F., twinning of crystals, 842
Wallis, F., polyphase transmission, 761
Walter, B., electric spark, 1890 ; frequency of electric sparks, 278 ; induction coils, 311 ; Röntgen rays, 38
Walter, B., & A. Voller, Wehnelt's interrupter, 1728
Wanach, B., curvature of surfaces, 1628 ; reversing prism, 1847
Wanner, H., 1671 ; broadening of D-lines, 1347
Wanner, H., & F. Paschen, emission function, 1138
Warburg, 102, 708, 1226, 1572
Warburg, E., point discharges, 275, 452, 453 ; sun's temperature, 1362 ; unpolarisable electrodes, 707
Ward Leonard, 1588
Wartz, 690
Wastchuk, 873
Waterhouse, J., iron-consuming batteries, 1952
Watmough, P. G., transformation of three-phase to two-phase currents, 1788
Watson, 1421
Watt, 343, 873
Waubel, W., electrolytic chlorates, 1239
Webb, H., eight subscribers on one pair of wires, 976
Webb, H. S., hysteresis, 1927 ; telephone party lines, 1459
Webber, W. O., cost of power, 358
Weber, 299, 1017, 1312
Weber, H. F., 1146.
Weber, R. H., measurement of resistance, 1913
Webster, 1696.
Webster, A. G., electrical oscillations, 88 ; theory of electricity and magnetism, 676
Wedding, W., arc lamps in series, 1448 ; volta lamps, 1308
Wehnelt, 1178, 1184, 1900
Wehnelt, A., canal rays, 566 ; contact breaker, 584 ; kathode rays, 1711
Wehnelt, A., & P. Spies, Wehnelt interrupter, 1521
Wehrenalp, B. von, telephone exchanges, 1998
Weihe, 1572
Weiler, W., bichromate cell, 1556
Weiss, P., 1930 ; galvanometers, 1185 ; plane magnetisation of pyrrhotine, 713
Weller, H. W., Boston railway, 1284
Wells, 1789
Wendell, G. V., rotary dispersion, 998
Wenström, 1951
Wesendonck, K., conductivity of flame gases, 101 ; point discharges, 274 ; thermodynamics, 675
West, earth returns, 1984
West J. H., atmospheric pressure, 16 ; single exchange line for five subscribers, 1832
Weston, C. P., deflection by small loads, 1619
Westphal, C., armature design, 1264
Wetherill, 1951
Wetler, A., prony brake, 742
Wetzstein, G., viscosity, 1623
Weyher, C., magnetic phenomena, 319
Wheeler, F. M., test of a feed-pump, 1077
Whitcher, J., boiler-feeding, 3.9
White, 759
White, A., 972
White, J. G., overhead construction, 1810
White, J. H., apparatus for spectroscopic photography, 1676
White, W. D., ampere-hour meter without jewels, 1766
White, W. F., transformer, 189
Whitehead, C. S., effect of a solid conducting sphere in a variable magnetic field on the magnetic induction at a point outside, 1700
Whitman, F. P., colour vision, 239 ; flicker photometer, 28
Wiebe, 665
Wiebe, H. F., & E. Gumlich, specific heat of liquids, 259

Wiechert, E., kathode rays, 1163
Wiechmann, F. G., atomic weights, 840
Wiedeburg, 578, 1015
Wiedeburg, O., absolute temperature, 50; electrothermal relation, 53; equations of condition, 1838; heat-stuff, energy and entropy, 1692; irreversible processes, 62
Wiedemann, 261, 276, 323
Wiedemann, E., 99, 775, 1895; kathode phenomena, 685; kathode rays, 36; luminescence, 1014
Wiedemann, E., & G. C. Schmidt, potential gradients in vaccum tubes, 280
Wien, 1348, 1701
Wien, M., 1572; magnetisation by alternate currents, 322
Wien, W., 818, 1138
Wiener, A. E., induction motors, 355
Wiener, O., fringes on daguerreotypes, 1473
Wild, H., determination of H., 1037
Wilderman, M., crystallisation, 1393
Wilhelmy, 1198
Wilkens, K., meter rates, 1446
Wilking, F. electric motor cars, 1597
Willcox, F. W., incandescent lamps, 1304
Williams, H. J., & R. S. Hale, calorific power of weathered coals, 499
Wilmhurst, electricity works, 1798
Wilsing, 244
Wilsing, J., spectra of new stars, 1649
Wilson, C. P., tramway track construction, 373
Wilson, C. T. R., 1679; condensation nuclei, 662
Wilson, Carus-, *see* Carus Wilson
Wilson, E., electric traction, 938; induction motors, 1275
Wilson, H. A., flames containing salt vapours, 1722; velocity of solidification, 778
Wilson, H. A., H. M. Dawson, & A. Smithells, conductivity of flames, 574
Wimshurst, 814
Wind, C. H., & H. Haga, diffraction of Röntgen rays, 1871
Winfield, J. H., long-distance telephony, 1614
Winkelmann, A., conductivity of glasses, 804; Röntgen rays, 797; thermal conductivities of glass, 441
Winteler, F., 1946; electrolysis of chlorides, 491; electrolytic perchlorates, 1407
Witkowski, 43
Witz, A., blast furnaces, 1258
Wohlwill, H., 1946; electrolysis of chlorides, 341
Wood, 878, 1591
Wood, R. W., artificial mirages and tornadoes, 1629; diffraction colour-photographs, 1664; dispersion of cyanin, 661; equilibrium figures, 407; reproduction of orbital motion, 20
Woodbridge, J. E., Niagara plant, 924
Woodfield, S., trolley car mishaps, 1293
Woolrich, 339
Wordingham, C. H., electricity works, 1798; wiring rules, 748
Worthington, A. M., & R. S. Cole, impact with a liquid surface, 1624
Wright, 1137, 1403
Wüllner, 1521
Wurts, 605

Yarnold, 598
Young, 1222, 1336
Young, J., conduit *v.* trolley, 627
Young, S., constants of normal heptane, 1687; thermal properties of gases and liquids, 262; thermal properties of isopentane, 1689
Young, S., & J. Rose-Innes, thermal properties of normal pentane, 1688
Yule, 13

Zacconi, 1202
Zeeman, 299, 422, 423, 793, 1139, 1928
Zehnder, 690
Zeidler, J., three-arc lighting system, 1603
Zeleny, J., 573; gases subjected to Röntgen radiation, 798; ionic velocities in Röntgenised gases, 251
Zellner, J., carbon electrodes, 1555
Zenišek, E., & E. Votoček, organic substitution products, 1552
Zenneck, J., alternate-current frequencies, 1514; Chladni plates, 264; vibrations of plates, 444
Ziegler, 1126
Ziffer, E. A., mechanical traction, 940
Zipernowsky, 505
Zodel, 196

SUBJECT INDEX.

To facilitate reference to any desired subject, the Index is divided into the following sections arranged alphabetically. If any of these are absent this may be taken as an indication that no Abstracts dealing with those particular subjects have been included in this volume :—

In General Physics :—Apparatus and Instruments (electrical, descriptive) ; Apparatus and Instruments (physical, excluding electrical, descriptive) ; Astronomy ; Elasticity ; Gravity ; Measurements (excluding instruments) ; Meteorology, &c. ; Miscellaneous ; Surface Tension ; Theories.

In Light :—Absorption (light and heat) ; Dispersion ; Interference ; Miscellaneous ; Phosphorescence and Fluorescence ; Photography ; Photometry ; Polarisation ; Radiation, Waves and Oscillations ; Rays ; Reflection ; Refraction ; Spectra ; Vision ; Zeeman Effect and Radiation in a Magnetic Field.

In Heat :—Absorption (light and heat) ; Conductivity (thermal) ; Critical Points and Constants ; Dilatation ; Freezing-, Melting-, and Boiling-Points ; Gases and Vapours ; Miscellaneous ; Specific Heat and Latent Heat ; Temperature ; Temperatures (high and low) ; Thermodynamics ; Vapour Pressure.

In Sound :—All Abstracts referring to this subject have been indexed under *Sound*.

In Electricity and Magnetism :—Absorption (electric) ; Alternate Current Research ; Capacity (electrostatic) ; Conductivity (electric) and Resistivity ; Dielectrics ; Discharge (electric) ; Induction ; Induction (self and mutual) ; Miscellaneous ; Polarisation (electric waves) ; Polarisation (electrolytic) ; Resonance ; Static Electricity ; Terrestrial Magnetism and Electricity ; Thermo-Electricity.

In Chemical Physics :—Absorption (chemical) : Chemical Equilibrium ; Dissociation and Ionisation ; Electric Furnace Processes ; Electrolysis (commercial) ; Electrolysis (except commercial) ; Electrolytic Analysis ; Miscellaneous ; Osmosis ; Solution and Solubility.

In General Electrical Engineering :—Accessories and Appliances (electrical, excluding traction) ; Batteries (primary) ; Batteries (secondary) ; Insulation and Insulators ; Machine Tools ; Miscellaneous ; Vats and Cells (electrolytic).

In Generators, Motors, and Transformers :—Alternators ; Dynamos ; Miscellaneous ; Motors ; Rectifiers ; Transformers and Rotary Converters.

In Power Transmission, Traction, and Lighting :—Accessories and Appliances (traction) ; Cables, Conductors and Wiring ; Cost of Electric Energy, &c. ; Electricity Works (descriptive) ; Lamps (arc) ; Lamps (incandescent) ; Miscellaneous ; Power Transmission and Distribution ; Traction (electric, by accumulators) ; Traction (electric, by trolley, conduit, or contact, &c.) ; Traction (mechanical).

In Telegraphy and Telephony :—Telegraphy ; Telephony.

Abstract Nos.

Absorption (Chemical Physics).

Gases Occluded by Moist Glass. F. Mehlhorn 1046
Hydrogen and Platinum. A. Mior 844
Oxides, Metallic, Retention of Gases by. T. W. Richards 593
Palladium, Occlusion of Hydrogen and Oxygen by. L. Mond, W. Ramsay, and J. Shields 1204

Absorption (Light and Heat).

Absorption of Röntgen Rays, *see* section Rays.
Brightness of Sources of Light. P. Jenko 994
Ebonite, Diathermancy of. E. Bianchi 673
Fluorescence, Change of Absorption produced by. J. Burke 1350
Infra-Red Absorption. H. Rubens and E. Aschkinass 21
Kirchhoff's Law. A. Cotton 1851
„ „ W. Voigt 1016
Magnetic Field, Absorption in. A. Righi 1476
Magneto-Optic Theory. W. Voigt 1140
Maxwell's Theory, Extension of. E. Edser 784
Minerals, Optical Properties of. H. Rosenthal 1848

Abstract Nos.

Absorption (Light and Heat), *continued.*
Transmission of Light through an Atmosphere containing Small Particles. Rayleigh 1655
Turbid Media, Transmission of Light by. P. Compan 1133
Uranyl Salts, Absorption by. E. Deussen 248
Absorption (Electric).
Absorption of Electric Waves. E. Branly and G. Le Bon 1167
Absorption of Electric Waves and Electroluminescence. H. Kauffmann 1499
Absorption of Röntgen Rays, *see* section Rays.
Oscillations, Electric. Drude 89
Transparency to Hertzian Waves. G. Le Bon 1500
Accessories and Appliances (Electrical, excluding Traction).
Alarms, Electric. J. Ebel 606
Battleships, Electrical Apparatus on. F. W. Roller 1076
Circuit Breaker, La Roche 888
Collisions at Sea, Prevention of. G. Dary 1075
Cut-out, Magnetic. M. Schiemann 1418
Detecting Objects at Sea. H. Herberts 347
Fuse-wires for Air-lines. J. Mattausch 1958
Fuses, Safe and Accurate. J. Sachs 1559
Lamp-holders, Screw-Socket, Standard Threads and Gauges for. R. Hundhausen 170
Lightning Arresters. Bochet 1957
„ „ H. E. Raymond 887
Lightning Arresters, American. H. E. Raymond 605
Lightning Arresters and Lightning. H. E. Raymond 1956
Mechanical Applications of Electricity. G. Richard 744, 1250
Pressure Regulator, Automatic 1964
Radiators, Alioth Alternate-Current. R. B. Ritter 1071
Regulator, G. E., for Series Arc-Lighters 1070
Safety Devices in Electrical Distribution. W. L. R. Emmet 1763
Stage Appliances, Electrical 741
Switch, Accumulator. H. Müller 1247
Switch, Automatic 889
Switch, Automatic, for Accumulators 1557
Switch, Rheostat 1558
Switchboards, Electric Light. S. H. Sharpstein 1072
Switching Gear for Accumulators, San Francisco. G. P. Low 925
Switching Gear for Accumulators, Heath and Field's 890
Synchroniser for Three-Phase Plant 892
Synchronisers for Three-Phase Generators. H. Müller 1774
Accessories and Appliances (Traction).
Accessories, Indispensable, of Electric Traction. H. E. P. Cottrell 1985
Brake Shoes 1990
Brakes, Electric. F. B. Booth 1297
Braking and Starting Resistances for Traction Motors. F. Erens 1767
Car Equipments. F. B. Perkins 377
Controller, New. J. C. Henry 529
Control, Thomson's System of Train 945
Intercommunication in Trains. W. E. Langdon 746
Line Material, Overhead, for Electric Railways. Benz 1986
Line Poles 376
Repair Shops at Cincinnati 1814
Switch, Detroit Automatic 634
Trolley Bases, Springs in. A. Hecker 1300
Trolley, Bow. Stobrawa 374
Wheels, Car, Thermal Tests for 1991
Alternate Current Research.
Alternate-Current Problems. T. R. Lyle 317
Alternating Current Circuits. De Bast 1732

For the **Explanation** of this Index see p. 909.

Alternate Current Research, *continued.* Abstract Nos.

Alternating Currents in Branching Circuits. H. T. Eddy 124
Commutated Current-Wave of Compound-wound Alternators. D. C. Jackson 183
Current-rushes in Transformers. A. Hay 193
Curve Tracer, Alternating Current. H. L. Callendar 127
Curve Tracer, Optical. J. A. Switzer 14
Görges Phenomenon and Coupling of Motors. F. Eichberg 753
Graphical Study of Alternate Currents. C. E. Guye 123
Kathode Rays in Investigating Alternating Currents. E. E. Seefehlner 1512
Leading Currents, Production of. O. Spitzer 1731
Photographing Variable Current Curves. H. J. Hotchkiss 1190
Rectification of Alternating Currents. P. Janet 125
Sine Curves in Alternating Current Problems. W. G. Rhodes 122
Transformer Diagram. F. G. Baum 1191
Transformer for 150,000 volts. E. B. Paine and H. E. Gough 188

Alternators.

Alternating-Current Machinery. E. J. Houston and A. E. Kennelly 911
Armature Winding for Multiphase Generators 354
Armature Windings, Multiphase. J. P. Stone 502
Armatures, Multiphase, Windings of. J. P. Stone 182
Brush Alternators, Improvements in. E. K. Scott 1777
Commutated Current-Wave of Compound-wound Alternator. D. C. Jackson 183
Compounding of Alternators. E. Danielson 1086
Compounding Alternators. M. Leblanc 908
Compounding Alternators for Constant Pressure. M. Leblanc 620
Hunting of Alternators. G. Kapp 1085
Induction Generators. M. Leblanc 1271
Induction Generator Tests. A. F. McKissick 184
Parallel Running. M. Leblanc 1272
Polyphase Generation 1575
Regulation of Alternating Current Generators. C. L. Cory 1974
Special Types of Alternators. F. J. Patten 1778
Synchronisers for Three-Phase Generators. H. Müller 1774
Synchronisers for Three-Phase Plant 892
Westinghouse Alternators at Madison Works, N.J. 1779

Apparatus and Instruments (Electrical, Descriptive).

Ammeter, Thermal. C. Camichel 827
Ammeter, Thermal Mercury. C. Camichel 118
Ammeter and Voltmeter, Combined G. E. 587
Ampere Balance. W. E. Ayrton and J. V. Jones 1186
Analyser, Harmonic. T. des Coudres 1035
Aron Energy-meter. J. Reyval 1954
Callendar's Recording Apparatus 1508
Chamberlain and Hokham's Two-rate Meter 1563
Cauderay Meter. M. Aliamet 897
Commutators, Exploring the Potential Round. G. D. Shepardson ... 316
Compass, Florian's. E. Gelcich 832
Contact-Maker, Instantaneous. J. Haralson, Jr. 1920
Curve Tracer, Alternating Current. H. L. Callendar 127
Curve Tracer, Optical. J. A. Switzer 14
Curve Tracer, Photographic. H. J. Hotchkiss 1190
Electrometer, Absolute. A. Perot and C. Fabry 315
Electrometer, Capillary. C. F. Burgess 111
Galvanometers, Diffraction. P. Weiss 1185
Hiecke Electric Meter 1069
Hysteresis Tester, Blondel-Carpentier. Armagnat 710
Influence Machine. W. R. Pidgeon 1915
Instruments, Electrical. C. T. Child 1032
Interrupter, Electrolytic. d'Arsonval 585

For the **Explanation** of this Index see p. 909.

Abstract Nos.

Apparatus and Instruments (Electrical, Descriptive), *continued.*

Interrupter, Electrolytic. A. Wehnelt 584
Interrupter for Induction Coils. F. Dessauer 1183
Interrupter, String. L. Arons 313
Interrupter, Tesla's 1033
Interrupter, Tudor's Electromagnetic 706
Interrupter, Wehnelt. H. Pellat 1031
" " A. Le Roy and others 1517
" " H. T. Simon 1919
" " A. Voller and B. Walter 1728
Interrupters, Tesla's Circuit 126
Long-Schattner Electrolytic Prepayment Meter 603
Long-Schattner Supply Meter 1955
Meter, Alternate-Current 166
Meter, Ampere-Hour, without Jewels. W. D. White 1766
Meter, Aron Energy. J. Reyval 1954
Meter, Cauderay. M. Aliamet 897
Meter, Chamberlain and Hookham's Two-rate 1563
Meter, Differential Rate. L. C. Reed 1562
Meter, Hiecke Electric 1069
Meter, Long-Schattner 1955
Meter, Long-Schattner Electrolytic Prepayment 603
Meter, Maximum Demand. E. S. Halsey 1561
Meter, Peloux Energy 1420
Meter Practice. L. C. Reed 895
Meter, Richard 896
Meter, Siemens Electric, Compensating Frictional Resistance in 604
Meter, Vulcain Energy. M. Aliamet 1419
Meters 167, 168
" H. Armagnat 1421
Meters, Energy, on Three- and Five-Wire Systems. P. Bary 635
Meters, Three-Phase 1764
Oscillographs. A. Blondel 1510
Peloux Energy Meter 1420
Permeameter, Commercial. M. Aliamet and E. J. Brunswick 114
Photometric Readings, Recorder. C. P. Mathews 542
Potentiometers, Commercial. Gosselin 828
Resistance Box 1509
Resistance Standards, High. F. B. Fawcett 1187
Richard Meter 896
Shunt, Universal 1730
Telephone, Differential, for Measurement of Electrolytic Conductivity. R. Federico 108
Temperature Coefficients. M. Solomon 314
Therapeutic Apparatus. W. J. Morton 1189
Tidal Analyser. R. A. Harris 540
Voltmeter, Electrostatic. A. Perot and C. Fabry 586
" " Svilokossitch 117
Voltameter, Mercury. L. Gourwitch 1188
Vulcain Energy Meter. M. Aliamet 1419
Wattmeter, Electrostatic. R. Arno 115
Wattmeter for Triphase Currents. J. W. Blackstone 705

Apparatus and Instruments (Physical, excluding Electrical, Descriptive).

Actinometer, Absolute. A. Crova 55
Actinometer, Alcohol. A. Crova 1334
Amyl Acetate Standard Lamp. W. M. Stine 1662
Analyser, Harmonic. J. N. Le Conte 13
Barometer. Brunn 1321
Barometer, Improved. K. R. Koch 646
Bolometers. S. P. Langley 54

For the **Explanation** of this Index see p. 909.

Abstract Nos.

Apparatus and Instruments (Physical, excluding Electrical, Descriptive), *continued.*

Brake, Improved Prony. A. Wetler 742
Colour Measurement. T. E. Doubt 240
Crystallography, Instruments for. C. Pulfrich 1331
Curve-Tracer and Integrator, Macrae 235
Diffusion, Determination of Rate of. A. Griffiths 1319
Engine Power Gauge. G. F. Atwood 494
Focometer, Oscillating. C. Dévé 1658
Grating, Rowland, Mounting of. W. E. Adeney and J. Carson 247
Grating-Spectroscope. H. Olsen 660
Gravity Balance. R. Threlfall and J. A. Pollock 1630
Illumination, Measurement of. Onimus 241
Interference Measurement-Apparatus. C. Pulfrich 3
Lighting of Polarisation Apparatus. F. F. Martens 794
Microseismograph. T. Gnesotto 1635
Objective, Telescopic, for Spectroscopic Use. C. S. Hastings 1472
Photometer. J. Hartmann 1660
Photometer, Actino. C. Henry 1661
Photometer, Self-correcting. B. Speed 1659
Piezometer. A. Pizzarello 401
Piezometer, High-Pressure. A. de F. Palmer 983
Power, Measurement of 175
Pump, Automatic Mercury. R. R. Lawrence 1835
Pumps, Geissler. G. Guglielmo 647
Pyknometer, Improved. A. Minozzi 1627
Quartz-Spectrographs and Apparatus. C. Leiss 795
Radiating Power of Platinum Black and Lampblack. F. Kurlbaum. 808
Refractometer. H. Starke 1332
Refractometer, Trough. W. Hallwachs 1333
Siderostat, Paris Exhibition. P. Gautier 1131
Spectroscope, Echelon. A. A. Michelson 1678
Spectroscope of Fixed Deviation. P. Pellin and A. Broca 1480
Spectroscope with Variable Scale. A. de Gramont 1677
Spectroscopy, Interferential. Jobin 250
Speed Indicator. W. H. Browne, Jr. 979
Temperature Regulator. E. Gumlich 1151
Thermal Radiation. K. Ångström 671
Thermometer, Aspiration-. P. Fuchs 805
Thermostat. R. Rothe 1690
Torque, Measuring. Boucherot 745
Volumenometer. A. Oberbeck 405

Astronomy.

α Aquilæ, Spectrum and Radical Velocity of. H. C. Vogel 988
α Cygni, Spectrum of. N. Lockyer 986
Comets, Phenomena Exhibited by. T. Bredichin 985
Dispersion in a Vacuum. L. Décombe 544
Chromosphere, Recent Research on. H. Deslandres 1839
Heat Radiation of the Stars. G. E. Hale 1841
Lunar Influence on Barometric Charts. A. Poincaré 1640
Moon, Physical Constitution of the. Lœwy and Puiseux 1464
Oxygen in Stellar Atmospheres. D. Gill 1650
Photography of Lunar Surface. Lœwy and Puiseux 17
Planetary Theory, Equations in. H. Ludendorff 1465
Seismic Movements, Influence of Moon on. U. Landi 1466
Solar Radiation. J. Janssen 19
Solar Spectrum, Telluric Lines in. A. de la Baume-Pluvinel 989
Spectra of New Stars. J. Wilsing 1649
Spectra of Northern Stars. F. McClean 987
Spectra, Stellar. A. Muller 990
Stability of Solar System. H. Poincaré 18

For the **Explanation** of this Index see p. 909.

Abstract Nos.

Astronomy, *continued.*
Stellar Radial Velocities. H. Deslandres 1648
„ „ „ F. Schlesinger 1647
Stellar Velocities. W. W. Campbell 233
Sun, Gallium in the. W. N. Hartley and H. Ramage 1840
Sun's Heat, Helmholtz's Theory. T. J. J. See 1469
Sun's Temperature. E. Warburg 1362
Terrestrial Pole, Movement of. E. F. Van de Sande Bakhuyzen 1645

Batteries, Primary.
Amalgams, Alkali-, Electrolytic. A. Schoeller 1062
Amalgams, E.M.F. between. H. P. Cady 727
Amalgams, Zinc and Cadmium. T. W. Richards and G. N. Lewis ... 1745
Bichromate Cell. W. Weiler 1556
Bichromate Cells, Efficiency of. W. Gratz and H. C. Schwecke 307
Carbon-Consuming Batteries. A. J. Rogers 1034
Carbon, Electricity direct from. F. Foerster 308
Charging Accumulators from Primary Batteries, Economy in. L. Brunelli 636
Chromium, Electromotive Behaviour of. Hittorf 1744
Clark and Cadmium Cells, E.M.F. of. S. N. Taylor 582
Clark Cells. E. Cohen 1507
Concentration Cells. R. Salvadori 1729
Concentration Cells, E.M.F. of. J. E. Trevor 1228
Concentration Cells with Insoluble Electrodes. K. Schaum 1227
Contact Electricity. A. Heydweiller 273
Contact Electrification. A. Coehn 1020
Contact and E.M.F. Q. Majorana 1385
Contact Force. J. Brown 1019
E.M.F. between Amalgams. H. P. Cady 727
Experimental Purposes, Batteries for 306
Galvanic Cell, Osmotic Theory of. W. Nernst and E. Bose 863
Galvanic Cells. G. Platner 862
Galvanic and Thermoelectric Action. C. J. Reed 701
Germain's Primary Battery 1953
Harrison Lead Peroxide Battery. J. D. Darling 1414
Hellesen Dry Battery 885
Internal Resistance and Polarisation of Cells. K. E. Guthe 578
Internal Resistance of Standard Cells. I. Klemenčič 95
Iron-Consuming Batteries. A. A. Beadle 1413
„ „ J. Waterhouse 1952
Jacques Cells. J. W. Langley 583
Liquid Cells and Ionisation of Fused Salts. C. McC. Gordon 728
Polarisation, *see also* section Polarisation.
Primary Batteries. E. Petersen 1067
Reaction-Velocity, Electrical. E. Cohen 1936
Standard Cells, Cadmium. J. Henderson 1921
Standard Cells, Internal Resistance of. I. Klemenčič 95
Standard Cells and Silver Voltameter. K. Kahle 112
Thermoelectric Battery. C. J. Reed 309
Voltaic Cell, Variance of. W. D. Bancroft 482

Batteries, Secondary.
Accumulator Construction. D. Fitz-Gerald 161
Ammonium-Chloride Accumulator with Carbon Plates. W. M. Stine 160
Cab Charging Station 381
Capacity of Accumulators. L. Jumau 1415
Charge, Curve of Accumulator. P. Girault 880
Charging Accumulators at Constant Pressure and at Constant Current. A. A. Cahen and J. M. Donaldson 159
Charging Accumulators from Primary Batteries, Economy in. L. Brunelli 636
Construction, Accumulator. D. Fitz-Gerald 884, 1417

For the **Explanation** of this Index see p. 909.

Abstract Nos.

Batteries, Secondary, *continued.*
Construction, Accumulator, New Method. A. Tribelhorn 1762
Diffusion in Accumulators. L. Jumau 310
Fulmen Accumulators and Motor Cabs in Paris. E. Hospitalier 602
O'Keenan's "Endoxyque" Battery 740
Motor Car Accumulators, Faure-Sellon-Volckmar 881
Motor Cars, Accumulators for. M. L. Inman 1761
" " P. Northey 1294
" " J. Reyval 600, 1246
Pescetto Accumulators 1245
Pulvis Accumulator 883
San Francisco, Accumulator at. G. P. Low 925
Tests, Accumulator. M. Schoop 1416
" " P. Schoop and H. Benndorf 1068
Tests of Traction Accumulators 882
Theory of Accumulators. E. Hoppe 1547
Theory of Lead Accumulators. F. Dolezalek 1546
" " K. Elbs 1743
Traction, Accumulators for. L. Schröder 1286
Vehicles, Electric, and their Relation to Central Stations. H. M. Maxim 902
Zinc Accumulators. G. Pellissier 601

Cables, Conductors, and Wiring.
Aluminium Conductors. J. B. C. Kershaw 1768
Aluminium, Iron and Copper as Conductors, Relative Cost of. J. B. C. Kershaw 164
Aluminium, Progress of 1065
Calculations, Wiring. A. Vallée 1566
Capacity of Cables, Utilising. H. Andriessen 900
Cars for Special Purposes 528
Concentric Wiring. M. O'Gorman 1959
Conduits, Air-tight 1610
Cost, Relative, of Copper, Aluminium, and Iron as Conductors. J. B. C. Kershaw 164
Country House Lighting. B. M. Drake 1104
Feeder System at Boston, U.S.A. 1977
High-Pressure Lines, Erection of. S. H. Dailey 173
High-Pressure Transmission Line, Erecting a. S. H. Dailey 613
Installation Estimates 1565
Interior Wiring. L. B. Chubbuck 1254
Iron, Aluminium, and Copper as Conductors, Relative Cost of. J. B. C. Kershaw 164
Multiphase Systems. W. S. Kelley 509
Networks of Conductors of Finite Dimensions. J. B. Pomey 1703
Overhead Line Construction. A. B. Herrick 1987
Pacific Cable. C. Bright 966
Railways, Electric, Return Feeders for. B. Böhm-Raffay 1811
Rules, Wiring. J. Pigg 747
" " C. H. Wordingham 748
Ship-wiring. J. C. Bagot 532
Submerged Conduits 514
Telephone Cables, Dielectric for 638
Telephone Cables, London-Birmingham 973
Telephone Cables, Paper 1255
" " " O'Gorman and Cozens-Hardy 1455
Three-Wire System, Conductor Resistance on. W. H. Donner 1073
Two-Wire Distribution. J. W. Howell 199
Underground Mains. L. A. Ferguson 1792
" " F. Jehl 172
Wiring Chart. R. L. Ellis 165
Wiring Rules. J. Pigg 477
" " C. H. Wordingham 748

For the **Explanation** of this Index see p. 909.

Abstract Nos.

Capacity (Electrostatic).
Cables, Telephone-. F. Breisig 1172
Capacity. I. I. Borgmann and A. A. Petrovsky 1029, 1501
Capacity in Alternating Circuits. C. F. Guilbert 709
Condensers in Alternate Current Transmission. L. Lombardi..... 1585
Dielectric Constant of Stretched Indiarubber. O. M. Corbino and F. Cannizzo 571
Parallel Wires, Two, Capacity of. J. B. Pomey 1707
Spheres in Contact, Capacity of. R. H. Jude 269
Stress, Influence of, on Capacity. U. Panichi 271
Wires, Capacity of. W. Moon 270

Chemical Equilibrium.
Affinity of Organic Bases in Aniline (Aminolysis). H. Goldschmidt and R. M. Salcher..... 1535
Amalgams and Solutions, Equilibrium between. A. Ogg 852
Binary Systems. W. D. Bancroft 855
Isothermal Pressure-surface for a Mixture of Two Single and One Resulting Double Salt. F. G. Donnan 594
Mutual Solubility : Vapour Pressure and Critical Points of Mixtures. J. P. Kuenen and W. G. Robson 1220
One-Component System. P. Saurel..... 1537
Phase Rule. P. Saurel 1217, 1218
Phases, Coexistent, Pressure of. M. Cantor 719
Reversible Reactions, Equation for. J. Waddell 1051
Solid State, Limits of the. G. Tammann 1693
Stereoisomers, Equilibrium of. W. D. Bancroft 1219
" " F. K. Cameron 487
Tautomeric Substances, Solidification of Mixtures of. H. W. B. Roozeboom..... 1221
Ternary Mixtures. W. D. Bancroft 1403
Transition-Points. H. Le Chatelier..... 1935
Two- or Three-Component Systems. G. Bruni 486
Three-Component System. N. Dodge and L. C. Graton 484
" " " J. F. Snell 483
Water-Alcohol-Succinonitrile System. F. A. H. Schreinmakers 853
Water—Sal Ammoniac—Iron Chloride System. E. C. J. Mohr 854

Conductivity (Thermal).
Air, Conduction of Heat in. Rayleigh 1359
Ebonite and Glass. A. Dina 1684
Electrothermal Relations. F. Kohlrausch 702
" " E. Riecke 299, 1024
Glass. T. M. Focke..... 440
" A. Winkelmann 441
Glasses, Conductivity of. A. Winkelmann..... 804
Ice. P. Straneo..... 1685
Insulation, Thermal. W. Hempel 1358
Iron, Cast, Conductivity of. E. H. Hall and C. H. Ayres 1357
Iron, Conductivity of, and Magnetism. D. Korda 1041
Iron and Copper. P. Straneo 56
Liquids. E. van Aubel 1146
Measurement of Thermal Conductivity. C. H. Lees 1148
Pressure and Conductivity. C. H. Lees 1147
Rocks, Conductivity of. F. Morano 672
Solids, Conductivity of. F. A. Schulze 803
Transmission of Heat through Plates. G. Haliday 57
Water, Conductivity of. S. R. Milner and A. P. Chattock..... 1356

Conductivity (Electric) **and Resistivity.**
Amalgams, Lead, Resistance of. G. W. Gressman 824
Arc, Electric, and Metallic Oxides, Conductivity of. W. B. Burnie and C. A. Lee..... 1504
Calculation of Electrolytic Conductivity. F. C. McKay..... 330

For the **Explanation** of this Index see p. 909.

Abstract Nos.

Conductivity (Electric) **and Resistivity,** *continued.*
Conduction in Rarefied Gases. E. Bouty 1893
Contact Resistance. F. Auerbach and A. Meyer 297
" " E. Branly 296
Copper, Conductivity of, in various Dielectrics. J. F. Merrill 1387
Copper Temperature-Coefficient 1170
" " " R. Appleyard ..... 150[illegible]
Cost, Relative, of Copper, Aluminium, and Iron as Conductors. J. B. C. Kershaw .....
Dielectric Conduction. W. Leick ..... [illegible]98
Double Salts, Conductivity of Solutions of. J. G. MacGregor and E. H. Archibald 595
Electrolytes, Conductivity of. W. Foster, Jr. 1545
Electrolytes, Law of Dilution of. T. P. Muller 1230
Electrolytes in a Magnetic Field. H. Bagard 469
Electrolytes, Moving, Resistance of. E. H. Hall 577
Electrothermal Relations. F. Kohlrausch 702
" " E. Riecke 299, 1024
Flame Gases. K. Wesendonck 101
Flames, Conductivity and Luminosity of. A. Smithells, H. M. Dawson, and H. A. Wilson 574
Flames Containing Salt Vapours. H. A. Wilson 1722
Fluidity and Electrolytic Conductivity. R. Dennhardt 1061
Gases, Conductivity of, exposed to Discharge Rays. J. J. Thomson 1895
Gases from Flames. J. A. McClelland 100
Gaseous Conduction in Incandescent Lamps. J. Stark 1894
Human Body, Resistance of the. J. E. Boyd 96
" " Dubois 97
Incandescent Lamps, Resistance. R. Apt and H. W. Hoffmann 99
Incandescent Lamps, Resistance of. J. C. Shedd 98
Iron and Copper. P. Straneo 56
Lead Peroxide, Conductivity of. T. Sundorph 1912
Manganin Standard Resistances. W. Jaeger and St. Lindeck 110
Measurement of Electrolytic Conductivity, Differential Telephone for. R. Federico 108
Measurement of High Resistances. J. Schürr 576
Nitric Acid. V. H. Veley and J. J. Manley 1171
Praseodymium and Neodymium, Conductivity of Solutions of. H. C. Jones and H. M. Reese 328
Selenium, Conductivity of, and Electromagnetic Waves. B. Agostini 291
Solids, Electrolytic Conductivity of, at High Temperatures. W. Nernst 1910
Temperature Coefficients. M. Solomon 314
Torsion, Effect of, on Resistance. C. de Szily 1721

Cost of Electric Energy, &c.
Alternating Current Supply, Charging. G. Benischke 1819
Charging for Electrical Energy. A. Meynier 387
Charging for Electrical Energy, Systems of. E. Hospitalier 1765
Charging for Energy. W. Arnot 950
" " G. Pellissier 949
Cost of Electrical Energy. M. E. Turner 386
Country House Lighting. B. M. Drake 1104
Docks and Harbours, Electrical Plant for. J. D. W. Aldridge 513
Economy in Electric Stations. E. P. Roberts 510
Electrical Transmission of Energy. A. Siemens 201
Heating, Electric 1568
Installation Estimates 1565
Les Clées-Yverdon, Transmission of Electrical Energy at. J. Laffargue 196
London, Electricity Supply of. A. H. Preece 1795
Meter Rates. E. L. Debell 1445

For the **Explanation** of this Index see p. 909.

Abstract Nos.

Cost of Electric Energy, &c., *continued.*
Meter Rates. K. Wilkens 1446
Midland Railway, Electric Light and Power on the. W. E. Langdon 203
Railways, Expenses of 1287
Steam and Water Power, Cost of. W. O. Webber 358
Traction, Cable, Electric and Horse, Costs of 524
Traction Costs. W. A. Harding 525
Traction, Electric and Steam, Comparison of. B. H. Thwaite..... 1594
Tramways, Cost of Electrical Energy for. R. W. Conant..... 368
Tramways, Electric, Cost of 214
Transformer, Alternating Current. W. F. White 185
Transformer Economy. W. E. Goldsborough..... 190

Critical Points and Constants.
Heptane, Normal, Constants of. S. Young 1687
Isopentane, Thermal Properties of. S. Young..... 1689
Mixtures, Vapour Pressure and Critical Points of : Mutual Solubility. J. P. Kuenen and W. G. Robson 1220
Pentane, Normal, Thermal Properties of. J. Rose-Innes and S. Young 1688

Dielectrics.
Air, Dielectric Strength of. C. P. Steinmetz..... 77
Ammonia, Electric Properties of. H. M. Goodwin and M. K. Thompson, Jr. 465
Condensers in Alternate Current Transmission. L. Lombardi..... 1585
Dielectric Conduction. W. Leick 298
Dielectric Constant of Stretched Indiarubber. O. M. Corbino and F. Cannizzo 571
Dielectric Constants. W. D. Coolidge 1906
„ „ J. A. Erskine..... 272
Dielectric Constants and Contact Electricity. A. Heydweiller 273
Dielectric Constants and Density. D. Negreano..... 1028
Dielectric Constants by Electric Waves. L. Barbillion..... 1713
Dielectric Constants and Temperature. H. Pellat and P. Sacerdote 463
Dielectric Hysteresis. H. Benndorf 94
Dielectric Strength. T. Gray 572
Dielectrics, Deformation of. P. Sacerdote..... 1907
Dielectro-Magnetic Media. V. Boccara and M. Pandolfi 1528
Dissociation and Dielectric Constants. H. Euler..... 1940
Glass, Dielectric Constant of. G. Ercolini..... 464
Heat and Moisture, Effect of. E. Letheule 1026
Ice, Dielectric Properties of. R. Abegg..... 74
Liquids, Dielectric, Currents in. A. Naccari..... 462
Polarisation, Dielectric, and Hysteresis. W. Schaufelberger 1027
Polarisation of Dielectrics. F. Beaulard. Also Potier 1908
„ „ Liénard 1726
Polarisation, Instantaneous. H. Pellat 1158
Polarisation, Persistent. H. Pellat 1159

Dilatation.
Air, Expansion of. W. Hoffmann 800
Alloys, Metallic, Expansion of. H. Le Chatelier 1530
Gases, Perfect, Dilatation of. D. Berthelot 1006
Glass and Changes of Temperature. M. L. Marchis 554
Glass and Thermometer Zero Points, Temperature Changes of. L. Marchis 1686
Ice, Expansion of. E. L. Nichols 1152
Iron and Steel, Dilatation of. H. Le Chatelier..... 1881
Linear Expansion. Vandevyver 442
Nickel and Cobalt, Expansion of. A. E. Tutton 1488
Porcelain, Dilatation of. T. G. Bedford..... 1880
Recalescence, Length-Variation of Iron and Steel during. G. E. Svedelius..... 1

For the **Explanation** of this Index see p. 909.

Abstract Nos.

Discharge (Electric), *see also* section Rays.
Air under Electric Stress. J. Trowbridge 281
Break-up of a Discharge. H. Abraham 1495
Brush Discharge. E. H. Cook 814
Brush Discharge, Stratified. M. Toepler 276
Charged Ion, Motion of, in a Magnetic Field. J. J. Thomson 1896
Chemical Actions of Discharge. Berthelot 1050
Condenser, Oscillatory Discharge of. E. H. Barton and W. B. Morton 1379
Condenser, Secondary Discharge of. R. Swyngedauw 75
Condensers, Discharge of. A. Garbasso 76
Conduction in Rarefied Gases. E. Bouty 1893
Constitution of the Electric Spark. A. Schuster and G. Hemsalech 1377
Deflection of Electric Discharge. J. Henry 468
Discharge, Disruptive. W. de Nikolaieve 1889
Discharge, Electric. J. Precht 1021
Discharge by Evaporation. H. Pellat 562, 1375, 1888
Discharge in a Liquid Dielectric. L. Décombe 78
Discharge Phenomena. N. Tesla 682
Discharge Rays, Conductivity of Gases exposed to. J. J. Thomson... 1895
Discharge, Velocity of Particles in, by Ultra-violet Light. H. Buisson 450
Discharges, Continuity of Vacuum. M. Cantor 564
Discharges, Electrical. J. Trowbridge 563
Flexible Spark Discharges. E. Lecher 1709
Gases traversed by Electric Discharge. E. Villari 816
Hertz Experiments. J. Precht 286
High-Frequency Experiments. N. Tesla 1383
Hittorf's Dark Space. H. Ebert 1897
Induction-Coil Discharges. A. Oberbeck 681
Induction Coil, Pressure of. A. Oberbeck 121
Inductoscripts. J. A. McClelland 996
Leyden Jar Discharge. R. Sywngedauw 79
Magnetic Deflection of Discharges. J. Precht 277
Point-Discharges. E. Warburg 275, 452, 453
„ „ K. Wesendonck 274
Point-Discharges, High-Frequency. F. Himstedt 1708
Potential Gradient at the Anode. C. A. Skinner 1901
Potential Gradients in Vacuum Tubes. E. Wiedemann and G. C. Schmidt 280
Short-circuited Secondary Coil. J. H. Smith 461
Spark Discharge in Solid and Liquid Dielectrics. J. Almy 1378
Spark, Electric, Genesis of. B. Walter 1890
Spark-Gap, Work Consumed in. E. Riecke 1892
Spark, Pressure within. E. Haschek and H. Mache 1891
Sparks, Electric. S. Leduc 451
Sparks, Electric, Frequency of. B. Walter 278
Spark, Gliding, on Glass. M. Toepler 279
Vapours from the Carbon Arc, Electrical Properties of. E. Merritt and O. M. Stewart 573

Dispersion (Light).
Anomalous Dispersion. Rayleigh 1344
Cyanin, Anomalous Dispersion of. R. W. Wood 661
Luminous and Electric Dispersion. L. Barbillion 1674
Model, Dispersion. J. H. Vincent 1854
Rotary Dispersion. G. V. Wendell 998
Selenite, Dispersion of. W. König 1849
Sodium Vapour, Anomalous Dispersion of. H. Becquerel 999

Dissociation and Ionisation.
Acids, Inorganic, New Class of. W. Hittorf and H. Salkowski 1404
Amalgams, Alkali-, Electrolytic. A. Schoeller 1062
Amalgams, E.M.F. between. H. P. Cady 727

For the **Explanation** of this Index see p. 909

Abstract Nos.

Dissociation and Ionisation, *continued.*

Amalgams and Solutions, Equilibrium between. A. Ogg 852
Ammonia, Electric Properties of. H. M. Goodwin and M. K. Thompson, Jr. 465
Calomel Electrode, Temperature Coefficient of the Potential of. T. W. Richards 581
Conduction in Mixed Electrolytes. H. Hoffmeister 1060
„ „ „ K. Hopfgartner 1059
Conductivity, Electrolytic. R. Abegg 1233
Conductivity, Electrolytic, Calculation of. F. C. McKay 330
Conductivity of Mixed Electrolytes. F. Barmwater 1232
Conductivity of Solutions of Double Salts. J. G. MacGregor and E. H. Archibald 595
Conductivity of Solutions of Praseodymium and Neodymium Sulphates. H. C. Jones and H. M. Reese 328
Constitution, Determinations of. K. Kieseritzky 1215
Dilution-Law, Validity of. J. J. van Laar 850
Dissociation and Dielectric Constants. H. Euler 1940
Dissociation Studies. W. D. Bancroft 1222
Dissociative Power of Solvents, Cause of. J. W. Brühl 861
Drop Electrodes. G. Meyer 734
„ „ W. Palmaer 1226
Efficiency of Electrolytic Processes. R. Moritz 736
Electrodes of the Third Kind. R. Luther 864
Electrolytes, Law of Dilution of. T. P. Muller 1230
Electrolytic Conduction under Pressure. A. Bogojawlensky and G. Tammann 733
Flames Containing Salt Vapours. H. A. Wilson 1722
Gases, Conduction of Electricity in. J. J. Thomson 1156
Heat of Solution, Ionisation, and Solubility of Electrolytes. A. A. Noyes 730
Heat of Solution and Solubility of Electrolytes. J. J. van Laar 729
Hydrolytic Dissociation. G. Platner 1398
Ionic Migration in Dilute Solutions. W. Bein 732
Ionisation, Calculation of. H. Jahn 1058
Ionisation and Chemical Composition. J. J. Thomson 859
Ionisation determined by means of Conductivity. A. A. Noyes 149
Ionisation of Dibasic Acids. W. A. Smith 1057
Ionisation of Polyvalent Salts. P. Calame 1229
Ionisation, Spectroscopic Test. E. Liveing 860
Ionising Power of Solvents. L. Kahlenberg and A. T. Lincoln 731
Ions, Mobility of. F. Kohlrausch 331
Liquid Cells and Ionisation of Fused Salts. C. McC. Gordon 728
Migration Constant of Hydrogen. D. McIntosh 147
Migration Constants of Acids. W. Hittorf and H. Salkowski 1404
Migration Constants for Zinc and Cadmium. G. Kümmell 148
Migration, Influence of Membranes on. W. Bein 1234
Neutralisation. G. Platner 1214
Nitrogen Peroxide, Dissociation of. A. Pochettino 846, 1539
Osmotic Theory of Galvanic Cell. W. Nernst and E. Bose 863
Potential Differences, Single. H. R. Carveth 102
Reaction Velocity, Theory of. S. Arrhenius 1202
Röntgen Ions, Charge Carried by. J. J. Thomson 1679
Sodium Mellitate, Cryoscopic Measurements of. W. W. Taylor 856
Solubility of a Binary Electrolyte in a Solution of another having Different Ions. A. A. Noyes 851
Solubility, Ionisation, and Heat of Solution. H. Goldschmidt 1056
Solubility of a Ternary Electrolyte, Influence of a Binary Electrolyte on. A. A. Noyes and E. S. Chapin 1231
Transference-Value of Hydrogen. W. D. Bancroft 481
Transition-Points. H. Le Chatelier 1935
Vapour Pressure of Solutions. C. Dieterici 843

For the **Explanation** of this Index see p. 909.

Abstract Nos.

Dynamos.

Air-Gaps, Magnetic Flux in. W. E. Goldsborough 909
Armature Coils, Reduction of Inductance of 181
Armature Design. G. Grassi 750
„ „ C. Westphal 1264
Armature Reaction. A. Potier 1571
Armature Testing. W. H. Hall 1432
Armature Windings. A. L. Rice 503
Armature Windings, Drum. A. L. Rice 352
Armatures, Balancing of. C. W. Hill 1267
Armatures, Stresses in Slotted. P. M. Heldt 1573
Balancers, Rotary. C. B. Davey 1269
Brush-Holders 351
Brushes, Contact-Resistance of, and Temperature of a Commutator. E. Arnold 1266
Brushes, Dynamo Without. A. Campbell 1268
Capacities, Dynamo and Motor. A. D. Adams 1274
Commutation, Effect of, on Field. W. H. Everett and A. H. Peake 751
Commutation, Sparkless. G. Kapp 1083
Commutation, Theory of. E. Arnold and G. Mie 1084
Commutator Design. F. J. A Matthews 621
Commutator Segments. F. X. Cicott 353
Commutators, Exploring the Potential Round. G. D. Shepardson ... 316
Commutators, Heating of. H. W. W. Dix 1574
Design, Dynamo. C. P. Poole 618
„ „ J. K. Sumee 179
Design, European and American. B. A. Behrend 1262
Drum Armature Windings. A. L. Rice 180
Dynamo-Electric Machinery. C. F. Guilbert 1270
Dynamos. C. F. Guilbert 1433
Dynamos, Study of. Della Riccia 749
Electric Generators. H. F. Parshall and H. M. Hobart 910
Electrolytic Generators and their Work 1754
E.M.F., Dynamo, Subdivision of. A. Sengel 1263
Field Distortion, Minimum, Generator with. R. Lundell 1576
Friction Losses in Dynamos. G. Dettmar 1775
„ „ J. Fischer-Hinnen 1776
Hysteresis Loss in Core-Discs. J. Epstein 1572
Induction Generators. M. Leblanc 500, 1429
Leakage, Magnetic, Preventing. J. F. Kelly 346
Losses, Dynamos, Analysis of. G. Dettmar 1430
Magnetic Flux in Air-Gaps. W. E. Goldsborough 909
Over-Compounding Dynamos. E. K. Scott 1973
Parallel, Shunt Dynamos in. A. Philip 501
Philadelphia Traction Company 520
Regulation, Sayers' Method. C. P. Feldmann 1265
Regulator, G.E., for Series Arc-Lighters 1070
Rushmore Multi-Circuit Dynamo, Tests of. E. J. Murphy, Jr., and P. E. van Saun 619
Stresses in Slotted Armatures. P. M. Heldt 1573
Study of Dynamos. Della Riccia 749
Testing, Armature. W. H. Hall 1432
Testing, Dynamo. C. Liebenow 1431

Elasticity.

Colloids, Compressibility of. C. Barus 982
Copper, Mechanical Properties of. M. Rudeloff 772
Deflection by Small Loads. C. P. Weston 1619
Deformation, Homogeneous. L. Januszkiewicz and W. Voigt 639
Deformation and Sliding. W. Voigt 1122
Deformations of Metals. M. Brillouin 640
„ „ G. Charpy 226

For the **Explanation** of this Index see p. 909.

Abstract Nos.

Elasticity, *continued.*
Glass, Elasticity of. R. Straubel 1620
Marble, Flexibility of. P. Gamba..... 641, 771
Marble, Flexibility of Baked. P. Gamba 1317
Muscle, Elasticity of, and of Rubber. A. Chauveau 643
Muscular Elasticity. A. Chauveau 411
Pendulums, Compound, Elasticity in. Helmert 402
Steel Wire, Elastic Properties of. A. D. Keigwin 1617
Thick Masses, Elasticity of. Ribière 11
Torsion. H. Bouasse 1316
Torsion and Recalescence of Steel. G. Moreau 538
Twisting Strains, Measurement of. E. G. Coker 642
Vibrating Wire, Period and Decrement of a. J. O. Thompson..... 1118
Waves, Elastic, Reflection and Refraction of. C. G. Knott 1633
Young's Modulus by Interference-Method. G. A. Shakespear 1618

Electric Furnace Processes.
Aluminium, Impurities in. A. Minet 1553
Calcium Carbide, Manufacture of. E. Segre 1412
Calcium Carbide Works at Ingleton. F. J. A. Matthews 157
Electro-Metallurgy. S. Cowper-Coles 490
Furnace, Carbide, Borchers' 1554
Furnace, Enclosed Electric 877
Furnace, Roberts' Electric 1244
Furnaces, Electric. F. J. Patten 879
Furnaces, Electric. G. Richard 878
Furnaces, Memmo Carbide..... 876
Smelting, Electric. W. S. Horry 158

Electricity Works (Descriptive).
Argentine Tramways 1098
Ashton Works and Tramways 1801
Belfast Electric Works..... 515
Blackburn Tramways 1096
Bommern-Witten Tramway. M. Schiemann 1981
Boston Electric Light Station..... 1588
Boston, New Union Station 1283
Boston Railway, Power House. H. W. Weller..... 1284
Boston Station 362
Bristol, Electrically Operated Auxiliary Plant at. H. F. Proctor..... 200
Bristol, Three-phase Installation at. W. Geipel 363
Brooklyn Company's New Stations 762
Brooklyn Electric Supply System. W. S. Barstow 1796
Cab Charging Station 381
Carlisle Electric Station 765
Chicago Elevated Railroad 518
Chicago, Power Station of Elevated Railway..... 1804
City of London Lighting Station 1093
Cleveland Railway Power Station 1285
Cork Electric Tramways. B. Griffin 206
Detroit Railways 1097
Distribution, Direct and Alternating Current. L. A. Ferguson 198
Electrical Transmission of Energy. A. Siemens 201
Fries Power Company, Transmission Plant of the 624
Generating Plant and Machinery in the Ivin's Building, N.Y. 1590
Glasgow Tramways 364
Granada, Transmission at. R. B. Ritter..... 766
Hamilton, Ontario, Transmission at 767
Lausanne Tramways. C. du Riche Preller..... 927
Les Clées-Yverdon, Transmission of Electrical Energy at. J. Laffargue 196
Lewiston, U.S.A., Line at 1099
Liverpool Tramways 517
Llandudno Works..... 361

For the **Explanation** of this Index see p. 909.

Abstract Nos.

Electricity Works (Descriptive), *continued.*
Niagara, Plant at. J. E. Woodbridge 924
Philadelphia Traction Company 520
Pittsburg Power Station 1095
Pittsburg, Power Station at. G. F. Greenwood 1094
Plymouth Electricity Works 1979
Potteries Electric Tramways 1980
St. Helens Electricity Works 1797
St. Louis, Central Station. G. A. Damon 204
St. Louis, Missouri-Edison Company. H. A. Wagner 205
San Francisco, Accumulator at. G. P. Low 925
San Gabriel Los Angeles Transmission. G. P. Low 923
Snoqualmie Falls Transmission Plant 516
Springfield and Holyoke Electric Railways, Mass. 208
Stansstad-Engelberg Railway 1100
Switzerland, Electrical Engineering in 1800
Test of Power Station 508
Traction Plant, Tests of. G. W. Munro 507
Washington, Lighting Station 511
Washington, Traction at 928

Electrolysis (Commercial).
Alkali Chlorides, Electrolysis of. F. Winteler 491
Alkali Chloride Solutions, Electrolysis of. Foerster 1946
Aluminium, Impurities in. A. Minet 1553
Aluminium, Progress of 1065
Bleaching, Electrical. V. Engelhardt 1948
Cadmium, Deposition of, and its Alloys. S. Cowper-Coles 339
Carbon Electrodes. J. Zellner 1555
Castner-Kellner Alkali Works. J. B. C. Kershaw 1243
Chlorate Works, Electrolytic, at Chedde, Savoy. J. B. C. Kershaw 1760
Chlorate Works, St. Michael Electrolytic. J. B. C. Kershaw 343
Chlorates, Bromates, Iodates, and Hypochlorites. W. Waubel 1239
Cleaning Metallic Surfaces by Electrolysis. C. F. Burgess 599
Copper-Depositing Process, Dumoulin. J. B. C. Kershaw 344
Copper Deposition, Becker's Method of. E. Ronco 738
Diaphragms for Electrolysis. H. Becker 737
Earth Returns and Electrolysis. A. V. Abbott 1810
" " " H. P. Brown 614
" " " A. B. Herrick 219, 941
" " " J. A. Fleming 218
" " " A. A. Knudson 899, 1074
Electro-Chemical Industries in 1898. J. B. C. Kershaw 598
Electro-Chemistry, Industrial, Position of. W. Borchers 1947
Electro-metallurgical Industries of England. J. B. C. Kershaw 872
Electro-metallurgy. E. Andreoli 1410
Electroplating the Hulls of Vessels 1241
Galvanising, Electrolytic. S. Cowper-Coles 342
Generators, Electrolytic, and their Work 1754
Gold, Electro-deposition of. E. Andreoli 875
Gold-Silver Alloys, Treatment of. A. Dietzel 1759
Metallurgy, Electricity as Applied to. R. Threlfall 597
Ozone, Electrolytic. E. Andreoli 1949
Refractory Ores, Cowper-Coles Process for 345
Soda and Bleach, Electrolytic. G. H. Robertson 1758
Sodium and Potassium, Electrolytic 1066
Sugar Refining by Electrolysis and Ozone. F. Peters 739
Syrup, Treating, with Ozone, Verley's Method 1409
Zinc Extraction, Electrolytic. J. B. C. Kershaw 1757

Electrolysis (except Commercial).
Alkali Chloride Solutions, Electrolysis of. Foerster 1946
Alkali-metal Chlorides, Electrolysis of. H. Wohlwill 341

For the **Explanation** of this Index see p. 909.

Abstract Nos.

Electrolysis (except Commercial), *continued.*
Alums, Electrolytic. J. L. Howe and E. A. O'Neal 735
Azo-Compounds, Electrolytic Synthesis of. W. Löb 1551
Azo- and Hydrazo-Compounds, Electrolytic. K. Elbs and O. Kopp 334
Benzoic Acid, Electrolysis of. C. Schall 1753
Beryllium, Electrolytic, and its Alloys. P. Lebeau 335
Brass, Electro-Deposition of. T. J. Baker and T. J. Baker, Jr. 1748
Cane-Sugar, Electrolysis of. K. Ulsch 1549
Carbamine, Electrolytic 1550
Chlorates, Bromates, and Iodates, Electrolytic. E. Müller 1408
Chromium, Deposition of. S. Cowper-Coles 340
Conduction without Electrodes. H. Behn-Eschenburg 1503
Conductors, Intermediate. J. Stark 301
Copper Sulphate, Electrolysis of. F. Foerster 1548
Dithio-disulphides, Electrolytic. C. Schall and S. Kraszler 867
Earth Returns and Electrolysis. A. V. Abbott 1810
" " " H. P. Brown 614
" " " A. B. Herrick 219, 941
" " " J. A. Fleming 218
" " " A. A. Knudson 899, 1074
Efficiency of Electrolytic Processes. R. Moritz 736
Electrolysis away from Electrodes. F. T. Trouton 1942
Electrolytic Gas, Electric Charge of. W. Kösters 1887
E.M.F. for Electrolysis, Limiting Values of. E. Bose 1235
Evolution, Electrolytic, of Hydrogen. A. Coehn 1941
Flow of Electrolytes through Partitions. F. T. Trouton 1909
Glucinum, Electrolytic. P. Lebeau 150
Hydrochloric Acid, Electrolysis of. Haber and Grindberg 1752
Hydrochloric Acid, Electrolysis of. D. Tommasi 1945
Indigo-Vats. A. Binz 153
Indigo-white, Formation of. A. Binz 154
Iron, Electrolytic, Carbon in. L. Houllevigue 865
Meta-nitro-toluene, Reduction of. A. Rohde 1236
Metallic Oxides, Electrolytic. Otto and H. Strecker 337
Metallurgy, Electricity as applied to. R. Threlfall 597
Mixed Electrolytes, Electrolysis of. J. G. MacGregor 1405
Nitrobenzene, Electrolytic. C. Schall and R. Klein 866
m-Nitro-p-toluidine, Electrolytic Reduction of. K. Elbs and B. Schwarz 336
Organic Electro-Chemistry. M. Krüger 489, 868, 1406
Organic Electrolysis by Alternating Currents. M. Krüger 1943
Organic Substitution Products. E. Votoček and E. Zenišek 1552
Palladium, Electrodeposition of 1749
Perchlorates, Electrolytic. F. Winteler 1407
β-Phenylhydroxylamine, Electrolytic. F. Haber 333
Platinum Chloride, Electrolysis of. W. Dittenberger and R. Dietz 1944
Siemens and Halske Process in the Transvaal. H. Pauli 155
Sodium Pertungstate. G. E. Thomas 1238
Solution, Electrolytic, of Noble Metals. M. Margules 329
Tungsten, Electrolytic. L. A. Hallopeau 488
Vanadium, Electro-deposition of. S. Cowper-Coles 869
Water, Electrolysis of. D. Tommasi 1063
Zinc Chloride Solutions, Electrolysis of: the Nature of Zinc Sponge. F. Foerster and O. Günther 151
Zincing, Electro-, Regenerative 156

Electrolytic Analysis.
Cadmium, Estimation of. E. Rimbach 871
Electrolytic Analysis. G. Arth 870, 1751
Lead, Estimation of. A. Hollard 596, 1237
Tin in Tin Ores. E. D. Campbell and E. C. Champion 152
Uranium and Cadmium. E. F. Smith and D. L. Wallace 338
Zinc, Electrolytic Estimation of. H. Paweck 1750

For the **Explanation** of this Index see p. 909.

Abstract Nos.

Freezing-, Melting-, and Boiling-Points.
Boiling-Point Curves. E. F. Thayer 667
Boiling-Points in the Magnetic Field. H. du Bois 1040
Boiling-Points of Mixed Liquids. J. K. Haywood 1542
Boiling-Points of Mixed Solutions. C. McC. Gordon, L. J. Henderson, and W. L. Harrington..... 1054
Boiling-Points of Mixed Solutions. T. W. Richards and W. L. Harrington..... 1053
Cast Iron, Melting-point of. R. Moldenke..... 669
Cryoscopic Behaviour of Alcohols. W. Biltz 1747
Cryoscopic Behaviour of Substances. F. Garelli and F. Calzolari ... 1543
Cryoscopic Investigation of the Terpenes. W. Biltz 857
Cryoscopic Measurement. F. M. Raoult 858
Cryoscopic Measurements of Sodium Mellitate. W. W. Taylor 856
Cryoscopic Solvents. F. Garelli 479
Freezing- and Boiling-Points. A. Battelli and A. Stefanini 1055
Freezing-points of Dilute Solutions. C. Dieterici 143
Hydrogen, Boiling-point of. J. Dewar 668, 1489
Melting-Point, Influence of Pressure on. E. Mack..... 47
Mixed Vapours, Composition of. H. R. Carveth 1391
Racemic Compounds and Mixtures. H. W. B. Roozeboom 1210
Surfusion of Metals and Alloys. W. C. Roberts-Austen..... 46
Ternary Mixtures. J. Waddell..... 1216

Gases and Vapours.
Characteristic Equation for Fluids. E. H. Amagat..... 1007
Compressibility of Gaseous Mixtures. D. Berthelot 1153
Conduction of Electricity in Gases. J. J. Thompson 1156
Dalton's Law. W. N. Shaw 257
Density of Liquids and Saturated Vapours. C. del Lungo 60
Dilatation of Perfect Gases. D. Berthelot..... 1006
Efflux of Gases. R. Emden 1836
Energy in Gases. E. Liveing 809
Joule's Law, Gases which obey. F. Carré..... 807
Kinetic Theory of Gases. F. Richarz..... 1013
Mixture of Gases. P. Sacerdote 1695
Molecular Volumes. A. Leduc..... 1491
Molecular Weight and Density of Fluids. D. Berthelot 541
Van der Waals' Equation. L. Boltzmann and H. Mache 1493
Vapours, Mixed, Composition of. H. R. Carveth..... 1391
Vapours, Saturated. E. H. Amagat..... 674

Gravity.
Balance, Gravity. R. Threlfall and J. A. Pollock..... 1630
Constant, Gravitational. F. Richarz and O. Krigar-Menzel 232
Density of the Earth. F. Richarz and O. Krigar-Menzel 1467
Determinations, Gravity. K. R. Koch..... 780
Etna, Value of Gravity near. A. Ricco 15
France, Geodesy in. Bassot 1124
Mont Blanc, Gravity on. P. Pizzetti 1125

Induction.
Axial Field of a Bobbin. L. Houllevigue 67
Effect of a Solid Conducting Sphere in a Variable Magnetic Field on the Magnetic Induction at a Point Outside. C. S. Whitehead 1700
Induction, Magnetic, in Electrical Measuring Instruments. A. Campbell..... 831
Magnetic Screening. C. Maurain 130
Magnetic Susceptibility of Liquids. G. Jäger and S. Meyer..... 131

Induction (Self and Mutual).
Measurement of Self-Induction. G. W. Patterson 1911
Measurement of Small Inductances. H. Martienssen 467
Self-Induction Experiments. A. G. Dell..... 1386

For the **Explanation** of this Index see p. 909.

Abstract Nos.

Insulation and Insulators.
"Fortis" Material. J. Reyval 894
Glass and Porcelain as Insulators. A. Fleury 1251
Granite as an Insulator 1560
Lithin 163

Interference.
Bands by two Gratings. F. F. Martens 420
Black Spot in Liquid Films, Thickness of. E. S. Johonnott, Jr..... 1338
Diffraction Fringes. L. N. G. Filon 1666
Fringes. A. Perot and C. Fabry 25
Fringes of High Order. C. Fabry and A. Perot 24
Newton's Rings. T. C. Porter 238
Slit, Orientation of, in Interference Experiments. J. Walker 419
Slit, Width of, in Interference Experiments. J. Walker..... 1337

Lamps (Arc).
A B C Lamp 1306
Arc Lamp 1823
Arc Lamps. E. W. Lehmann-Richter 1604
" " G. Richard 958, 1449
" " R. A. Ross 956
Bergmann Arc Lamp. P. Letheule..... 954
Carbons, Manufacture of. F. Jehl 169
Cotsworth Arc Lamp 389
Differential Arc Lamp. C. Vigreux and L. Brillié 1447
Duflos Arc Lamp 533
Formulæ, Arc Light. W. Harkness..... 952
Ninety-five Volt Lamp. A. D. Adams..... 1307
Photometry of the Arc. C. P. Mathews. W. H. Thompson, and J. E. Hilbish..... 951
Series, Working Arc Lamps Three in. W. Wedding 1448
Sonia Enclosed Arc Lamp 955
Submarine Arc Lamp 957
Test of an Enclosed Arc Lamp. E. Gerard and O. de Bast..... 1605
Thomson-Houston Enclosed. T. Pausert 1105
Three-Arc Lighting System. J. Zeidler 1603
Volta Lamps. W. Wedding 1308

Lamps (Incandescent).
Candle-power of Glow Lamps. R. A. Fessenden 1128
Desaymar Incandescent Lamp 1821
Filaments, Incandescent Lamp, Effect of Fire-damp on. H. Couriot and J. Meunier 608
Filaments, Making Lamp, Maxim's Method 1252
Gaseous Conduction in Incandescent Lamps. J. Stark 1894
Good and Bad Lamps. F. W. Willcox 1304
High Efficiency Incandescent Lamps. B. L. Montel 1820
Incandescent Lamps. S. E. Doane..... 388
Lamp-holders, Screw-socket, Standard Threads and Gauges for. R. Hundhausen 170
Large Incandescent Lamp 1822
Life of Incandescent Lamps. B. L. Montel 953
Nernst Electric Lamp. J. Swinburne..... 959
Nernst's Lamp, Precursors of. E. de Fodor..... 1602
"Premier" Lamp, Silicon Carbide 1305
Resistance of Incandescent Lamps. R. Apt and H. W. Hoffmann... 99
Resistance of Incandescent Lamps. J. C. Shedd 98

Machine Tools.
Cleaning Water-tube Boilers 497
Drilling Machine, Portable Electric..... 1968
Midland Railway, Electric Light and Power on the. W. E. Langdon 203
Shipyard Tools, Electrically Driven. F. von Kodolitsch 609
Steel-making, Electric Power in. E. B. Clark 1969
Workshop Practice. F. Bathurst..... 1962

For the **Explanation** of this Index see p. 909.

Abstract Nos.

Measurements (excluding Instruments).
Alternating Currents, Measurements with. H. A. Rowland and T. D. Penniman 1724
Arc of the Meridian, Measurement of an. Bassot 1636
Capacities, Measuring Small. I. I. Borgmann and A. A. Petrovsky... 1029
Colour Measurement. T. E. Doubt 240
Condenser Losses. E. B. Rosa and A. W. Smith 588, 589
Conductivity, Electrolytic, Differential Telephone for Measurement of. R. Federico 108
Conductivity, Thermal, Measurement of. C. H. Lees 1148
Conductor-resistance of Cables. W. J. Murphy 294
Diameters, Optical Measurement of. M. Hamy 655
Dynamo Losses, Analysis of. G. Dettmar 1430
Dynamo Testing. C. Liebenow 1431
Earth Current, Schaefer's Break Test. W. J. Murphy 295
Electrical Quantity, Direct Measurement of. R. Blondlot 1502
Faults in Submarine Cables, Detecting. E. Jona 1173, 1174
Faults, Test to. A. Jordan and W. Schonau 1030
Frequencies, Alternate-Current. J. Zenneck 1514
Frequency of Alternating Currents, Measurement of. C. Kinsley ... 1513
Galvanometers, New Method of Using. Féry 1511
Height, Barometric Determination of. L. Papanti 1637
Illumination, Measurement. Onimus 241
Inductance, Measurement of. S. T. Moreland 696
Inductances, Small, Measurement of. H. Martienssen 467
Insulation, Battery, Measurement of. C. Liebenow 1723
Insulation Test, Raymond-Barker's. A. D. Constable 826
Insulation of Three-Wire System. J. Kollert 1914
Instrument-Reading. F. G. Baum 1114
Leakage, Current, Measurement of. M. Kallmann 695
Length, Optical Measurement of. C. Fabry, J. M. de Lépinay and A. Perot 1112
Length and Thickness, Interferential Measurement of. A. Perot and C. Fabry 980
Metrology, Interference applied to. A. Perot and C. Fabry 1643
Micrometers, Correction of, by Interference. M. Hamy 2
P.D. at Feeding-Points. J. Teichmüller 1180
Phase-Difference. C. Breitfeld 1179
Photometry of the Arc. C. P. Mathews, W. H. Thompson, and J. E. Hilbish 951
Pitches, Determination of. C. Stumpf 1369
Potential Differences, Single. H. R. Carveth 102
Power, Measurement of 175
Power Station, Test of 508
Pressure and Temperature, Measurement of. K. Scheel 1874
Pressures, Measuring High Electric. W. Peukert 694
Quartz Plate Normal to the Axis. R. Dongier 656
Raymond-Barker's Insulation Test. A. D. Constable 826
Resistance of Incandescent Lamps. R. Apt and H. W. Hoffmann... 99
Resistance, Measurement of, by Damping. R. H. Weber 1913
Resistances containing Earth Currents. R. R. Black 825
Resistances, High, Measurement of. J. Schürr 576
Resistances, Low, Comparing. H. L. Callendar 697
" " " J. B. Pomey 1176
Saturation-Point of Solutions, Electrical Determination of. J. H. van't Hoff 1937
Self-Induction, Measurement of. G. W. Patterson 1911
Slip in Induction Motors. M. v. Hoor 1579
Speed, Frequency and Lag, Stroboscopic Determination of. G. Benischke 1116
Standards of Measurement. H. S. Carhart 109

For the **Explanation** of this Index see p. 909.

Abstract Nos.

Measurements (excluding Instruments), *continued.*
Temperatures, Flame. F. Berkenbusch 670
Temperature, Measurement of 48
Thermal Radiation. K. Ångström 671
Thévenin's Theorem. J. B. Pomey 1025
Traction Plant, Tests of. G. W. Munro 507
Voltameter, Silver, and Standard Cells. K. Khale 112
Volumes of Aqueous Solutions. E. B. H. Wade 1211
Volumes, Measurement of. J. Wagner 1113

Meteorology, &c.
Atmospheric Pressure. J. H. West 16
Clouds, Height of. A. Sprung 1639
Göttingen, Meteorological Observations at. G. Kümmell 1126
Kites, Meteorological Registration by. L. T. de Bort 1642
Magnetic and Meteorological Phenomena. v. Rijckevorsel 838
Periodicity in the Weather. H. H. Clayton 1641
Temperature in the Atmosphere. L. T. de Bort 1843
Temperature and Vapour Gradients in the Atmosphere. F. H. Bigelow 1644
Temperatures on Mountain-tops. J. Hann 782
Thermometer, Aspiration-. P. Fuchs 805

Miscellaneous (Chemical Physics).
Absorption, *see* separate section.
Acetylene, Explosive Properties of. G. Claude 1206
Air, Free Hydrogen in. A. Gautier 477
Affinity of Organic Bases in Aniline (Aminolysis). H. Goldschmidt and R. M. Salcher 1535
Alloys, E.M.F. and Heat of Formation. M. Herschkowitsch 849
Alloys, Expansion of. H. Le Chatelier 1530
Alloys of Iron and Nickel. F. Osmond 1203
Alloys, Microstructure of. J. E. Stead 716
Alloys of Nickel. C. E. Guillaume 234
Alloys and Röntgen Ray Photography. C. T. Heycock and F. H. Neville 1394
Aluminium, Application of. H. Moissan 1532
Aluminium, Impurities in. A. Minet 1553
Aluminium, High-Temperatures by means of. H. Goldschmidt 1950
Aluminium, Progress of 1065
Aluminium, Properties of. A. Ditte 847, 1064, 1531
Aluminium, Solder for 162
Amalgams of Alkali-Metals. E. Macy 1536
Amalgams, Zinc and Cadmium. T. W. Richards and G. N. Lewis ... 1745
Arc, Chemical Applications of the. Bredig 146
Arc, Electric, and Metallic Oxides, Conductivity of. W. B. Burnie and C. A. Lee 1504
Atmospheric Gas, Supposed New. O. Neovius 139
Atmospheric Gases, New. W. Ramsay 1207
Atomic and Molecular Weights, Determining. D. Berthelot 1209
Atomic Weights. F. G. Wiechmann 840
Atomic Weights of Oxygen and Hydrogen. A. Leduc 1533
Calomel Electrode, Temperature Coefficient of the Potential of the. T. W. Richards 581
Caoutchouc, Action of Gases on. D'Arsonval 1739
Chemical Equilibrium, *see* separate section.
Chromium, Electromotive Behaviour of. Hittorf 1744
Colloid Solutions, Coagulation of. J. Stark 1741
Colloids, Compressibility of. C. Barus 982
Constitution, Determinations of. R. Kierseritzky 1215
Contact, Molecular. J. S. Stevens 403
Crystalline Structure of Metals. J. A. Ewing and W. Rosenham 1196
Crystallisation, Process of. A. Heydweiller 1047
" " G. Tammann 326

For the **Explanation** of this Index see p. 909.

Miscellaneous (Chemical Physics), *continued.* Abstract Nos.
Crystallisation-Velocity. G. Tammann 145
" " A. Bogojawlensky 1197
" " M. Wildermann 1393
Crystallography, Instruments for. C. Pulfrich 1331
Crystals, Structure of. W. J. Sollas 144
Crystals, Twining of. F. Wallerant 842
Density, *see* separate section.
Diffusion, Determination of Rate of. A. Griffiths 1319
Diffusion through Ferrocyanide Membranes. A. Naccari 478
Diffusion of Gases in Liquid. G. Hüfner 723
Diffusion of Sulphides through Steel. E. D. Campbell 137
Diffusive Convection. A. Griffiths 406
Diffusive Convection, Source of Energy in. A. Griffiths 1318
Dilution, Thermal Effects of. J. H. Pollock 1396
Dissociation and Ionisation, *see* separate section.
Electric Currents, Action of, on Photographic Plates. E. Jahr 984
Electric Furnace Processes, *see* separate section.
Electrochemical Equivalent of Silver. G. W. Patterson, Jr., and K. E. Guthe 1727
Electrochemical Theory. R. Mewes 1213
Electrode, Calomel, Temperature Coefficient of the Potential of the. T. W. Richards 581
Electrodes, Drop. W. Palmaer 1226
Electrodes of the Third Kind. R. Luther 864
Electrolysis, *see* separate sections.
Electrolytes, Flow of, through Partitions. F. T. Trouton 1909
Electrolytes, Luminous. E. Lagrange 1178
Electrolytic Analysis, *see* separate section.
Electromotive Force on Mixing Liquids in a Magnetic Field. R. Blondlot 1733
Electrosynthesis. W. G. Mixter 1049
Equivalent, Electrochemical, of Silver. G. W. Patterson, Jr., and K. E. Guthe 1727
Etherion. W. Crookes 717
Etherion—a New Gas. C. F. Brush 325
Explosion. C. E. Munroe 1388
Explosion in Gases, Rate of. D. L. Chapman 776
Explosive Gases. W. G. Mixter 1389, 1390
Ferrocyanide Membranes, Diffusion through. A. Naccari 478
Fire-damp, Effect of, on Incandescent Lamp Filaments. H. Couriot and J. Meunier 608
Gas, Supposed New Atmospheric. O. Neovius 139
Gases, Recently Discovered. W. Ramsay 841
Glass, Colloidal. C. Barus 1043
Glass, Hydrated, Thermodynamic Relations of. C. Barus 1044
Hall Effect in a Binary Electrolyte. F. G. Donnan 1384
Hydrolysis of Maltose, Velocity of. A. von Sigmond 1198
Hydrolysis of Stannic Chloride. W. Foster, Jr. 1938
Indiarubber, Vulcanised. H. L. Terry 1534
Iodine Compounds. E. C. Sullivan 1397
Iodine Vapour, Colour of. J. Dewar 785
Ionisation, *see* section Dissociation.
Iron and Nickel, Alloys of. F. Osmond 1203
Iron and Steel, Cast. B. S. Summers 1526
Iron and Steel, Passive State of. L. Houllevigue 141
Iron and Steel Solution Theory. H. J. von Jornstorff 848, 1742
Luminous Electrolytes. E. Lagrange 1178
Magnetic Field, Electromotive Force on mixing Liquids in. R. Blondlot 1733
Magnetism, Chemical Action of. E. Jahr 837

For the **Explanation** of this Index see p. 909.

Abstract Nos.

Miscellaneous (Chemical Physics), *continued.*

Mercury, Extraction of 1240
Metallography. E. Heyn 1395
Metals, Crystalline Structure of. J. A. Ewing and W. Rosenham ... 1196
Metals, Deformation of. G. Charpy 226
Metals, Physical Properties of. H. F. Parshall and H. M. Hobart ... 981
Molecular and Atomic Weights, Determining. D. Berthelot 1209
Molecular Contact. J. S. Stevens 403
Molecular Forces. W. Mueller-Erzbach 774
Molecular Volumes. A. Leduc 1491
Molecular Weight and Density of Fluids. D. Berthelot 541
Molecular Weight of Liquids. D. Berthelot 721
Molecular Weights of Liquids. E. L. Speyers 136
Molecular Weight of Sulphur. H. T. Barnes 1208
Neon, Predictions of. W. Sedgwick 718
Neutralisation. G. Platner 1214
Nickel and its Alloys. C. E. Guillaume 234
Nickel and Iron, Alloys of. F. Osmond 1203
Nickel Steel. C. E. Guillaume 1523
Nitrogen Peroxide Dissociation. A. Pochettino 846
Occlusion of Hydrogen and Oxygen by Palladium. L. Mond, W. Ramsay, and J. Shields 1204
Ore Separators, Magnetic. H. C. McNeill 1951
Osmosis, *see* separate section.
Ozone, Sterilising Water by. E. Andreoli 1756
„ „ „ J. Blondin 1755
Palladium, Occlusion of Hydrogen and Oxygen by. L. Mond, W. Ramsay, and J. Shields 1204
Passive State of Iron and Steel. L. Houllevigue 141
Permeability of Cast Iron, Effect of Silicon on. F. C. Caldwell 711
Photoelectric Currents. G. C. Schmidt 1212
Photographic Plates, Action of Electric Currents on. E. Jahr 984
Powders, Heat Developed on Wetting. G. Ercolini 845
Precipitation, Pseudo-. J. Stark 1740
Pressure, Influence of, on Formation of Tachydrite. J. H. van't Hoff and H. M. Dawson 1939
Racemic Compounds and Mixtures. H. W. B. Roozeboom 1210
Reaction Velocity. R. H. Bradbury 1538
„ „ A. v. Hemptinne and A. Bekaert 1200
„ „ A. A. Noyes and G. J. Cottle 1199
Reaction Velocity in Aqueous Alcohol. W. Kistiakowsky 1048
Reaction Velocity, Electrical. E. Cohen 1936
Reaction Velocity, Theory of. S. Arrehenius 1202
Reactions, Reversible, Equation for. J. Waddell 1051
Separators, Magnetic Ore. H. C. McNeill 1951
Solder for Aluminium 162
Solid and Liquid, Transition between. G. A. Hulett 1392
Solid State, Limits of the. G. Tammann 1693
Solidification of Mixtures of Tautomeric Substances. H. W. B. Roozeboom 1221
Solidification, Velocity of. H. A. Wilson 778
Solution and Solubility, *see* separate section.
Solvents, *see* section Solution.
Starch, Gelatinisation of. H. Rodewald 327
Steel and Iron, Passive State of. L. Houllevigue 141
Steel and Iron, Solution Theory. H. J. von Jornstorff 848
Sterilising Water by Ozone. E. Andreoli 1756
„ „ „ J. Blondin 1755
Sulphur, Alleged Decomposition of (Bythium). H. Alexander 332
Surfusion of Metals and Alloys. W. C. Roberts-Austen 46
Synthesis, Electro-. W. G. Mixter 1049

For the **Explanation** of this Index see p. 909.

Abstract Nos.

Miscellaneous (Chemical Physics), *continued.*
Tachydrite, Influence of Pressure on Formation of. J. H. van't Hoff and H. M. Dawson 1939
Temperatures, High-, by means of Aluminium. H. Goldschmidt ... 1950
Transition-Points. H. Le Chatelier..... 1935
Triboluminescence. W. J. Pope 1680
Vacua, High, by Liquid Hydrogen, with their Spectroscopic Examination. J. Dewar..... 592
Vapours : for gaseous laws *see* section Gases.
Velocity of Hydrolysis of Maltose. A. von Sigmond 1198
Velocity, Reaction-. R. H. Bradbury 1538
„ „ A. v. Hemptinne and A. Bekaert 1200
„ „ A. A. Noyes and G. J. Cottle 1199
Velocity, Reaction-, in Aqueous Alcohol. W. Kistiakowsky..... 1048
Velocity, Reaction-, Electrical. E. Cohen..... 1936
Velocity, Reaction-, Theory of. S. Arrhenius 1202
Victorium, a New Element. W. Crookes 1737
Viscosity, *see* section Miscellaneous (General Physics).
Vulcanised Indiarubber. H. L. Terry 1534
Wetting Powders, Heat Developed on. G. Ercolini 845
Wires, Incandescent, Disintegration of. W. Stewart 7
Zinc Sponge, Nature of : Electrolysis of Zinc Chloride Solutions. F. Foerster and O. Günther 151

Miscellaneous (Generators, Motors, and Transformers).
Alternators, *see* separate section.
Commutators, Exploring the Potential Round. G. D. Shepardson ... 316
Dynamos, *see* separate section.
Eddy Currents and Hysteresis. A. Grau 473
Magnet Steels. F. Osmond 1524
Magnetic Properties of Sheet Iron. W. Rohr 712
Magnetic Properties of Steel. Mme. Sklodowska-Curie..... 134
Motors, *see* separate section.
Rectifiers, *see* separate section.
Resistances, Starting and Braking for Traction Motors. F. Erens... 1767
Transformers and Rotary Converters, *see* separate section.

Miscellaneous (Electricity and Magnetism).
Absorption (Electric), *see* separate section.
Alternate Current Research, *see* separate section.
Alternating Currents, Physiological Action of. J. L. Prevost and F. Battelli..... 651
Arc, Alternating Electric. A. Blondel..... 678
Arc, Carbon, Electrical Properties of Vapours from. E. Merritt and O. M. Stewart..... 573
Arc, Chemical Applications of the. Bredig 146
Arc, Electric. F. Eichberg and L. Kallir 679
„ „ J. Sahulka 103
Arc, Electric, Drop of Potential in. Mrs. Ayrton..... 304
Arc, Electric, and Metallic Oxides, Conductivity of. W. B. Burnie and C. A. Lee..... 1504
Arc, Photographic Study of the. N. H. Brown..... 1720
Arcs, Alternate Current. W. Duddell and E. W. Marchant 829
Arcs, Electric. F. Eichberg and L. Kallir..... 830
Arcs, Metal-Carbon. A. Blondel 680
Arcs and Non-arcing Metals. G. T. Hanchett 886
Atmospheric Electricity, *see* section Static Electricity.
Bolometer and Thermopile, Conditions of Sensitiveness. H. C. Pocklington 1876
Capacity (Electrostatic), *see* separate section.
Capillary Phenomena, Electro-. S. W. J. Smith 821
Cells, Voltaic, *see* section Batteries (Primary).
Coherer, Anti-. A. Neugschwender..... 1380

For the **Explanation** of this Index see p. 909).

Abstract Nos.

Miscellaneous (Electricity and Magnetism), *continued.*

Coherer, Carbon. T. Tommasina 1023
Coherer, De-, Magnetic. T. Tommasina 1166
Coherer, New Form of. A. G. Dell 1719
Coherer-Sparks. R. Malagoli 458
Coherers. E. Aschkinass 292
„ O. Behrendsen 293
„ A. Blondel 457
„ T. Tommasina 692, 1718
Coherers, Action of. T. Sundorph 1717
Coherers, Ball. E. Branly 1164
Coherers, Electrolytic. T. Tommasina 1165
Coherers, Materials for. E. Dorn 106
Coherers of Gold and Platinum. E. Branly 693
Coherers, Theory of. D. van Gulik 105
Cohering Action of Metals. J. C. Bose 1716
Condenser Losses. E. B. Rosa and A. W. Smith 588, 589
Condenser, New 1248
Condensers, *see* also sections on Dielectrics and on Discharge.
Conduction of Electricity in Gases. J. J. Thomson 1156
Contact Electricity, *see* section Batteries (Primary).
Conductivity (Electric) and Resistivity, *see* separate section.
Crookes Tubes, *see* Tubes, Crookes.
Crystals, Magnetisation of. A. Lutteroth 323
Current Curves, Photographing Variable. H. J. Hotchkiss 1190
Current, Residual, Theory of. E. Salomon 1052
Currents, Earth, *see* section Terrestrial Magnetism.
Damping of Galvanometer Needles. H. Lemke 823
Dielectrics, *see* separate section.
Dimensions of Electrical Units. K. Schreber 1702
Discharge (Electric), *see* separate section.
Discharge Rays, *see* section Rays.
Distant Mechanism, Control of 898
Earth Currents, *see* section Terrestrial Magnetism.
Electric Currents, Action of, on Photographic Plates. E. Jahr 984
Electric Field, Graphic Representation of. E. Bourdréaux 1157
Electric Field, Optical Properties in. W. Voigt 1857
Electricity and Magnetism. A. G. Webster 676
Electricity, Mechanical Theory of. Holzmüller 1155
Electrification, *see* section Static Electricity.
Electro-capillary Phenomena. S. W. J. Smith 821
Electrochemical Equivalent of Silver. W. Patterson, Jr., and K. E. Guthe 1727
Electrodynamic Equation of a Moving Material Medium and Electrostriction. J. Larmor 66
Electromagnetic Theory. O. Heaviside 68, 812
Electromotive Force on Mixing Liquids in a Magnetic Field. R. Blondlot 1733
Electrostatics, *see* section Static Electricity.
Electrostriction and Electrodynamic Equation of a Moving Material Medium. J. Larmor 66
Electro-Thermal Relations. E. Riecke 299, 1024
„ „ „ W. Voigt 822
„ „ „ O. Wiedeburg 53
Equilibrium Figures. R. W. Wood 407
Ferro-Nickels, Magnetism in. L. Houllevigue 1193
Field, Electric, *see* Electric Field.
Field, Magnetic, *see* Magnetic Field.
Flames, Electric Conductivity and Luminosity of. A. Smithells, H. M. Dawson, and H. A. Wilson 574
Fog and Electricity. A. Garbasso 449

For the **Explanation** of this Index see p. 909.

Miscellaneous (Electricity and Magnetism), *continued.* Abstract Nos.
Frequencies, Alternate Current. J. Zenneck 1514
Galvanometer Needles, Damping of. H. Lemke 823
Galvanometers, *see also* section Apparatus.
Galvanometers. W. E. Ayrton and T. Mather 703
Galvanometers, New Method of Using. Féry 1511
Galvanometers, Sensitiveness of. C. Féry 704
Galvanometry, Ballistic. C. Barus 113
Hall Effect in a Binary Electrolyte. F. G. Donnan 1384
Hematite, Magnetic Properties of. A. Abt 1924
Hertz and Maxwell, Expressions of, for Magnetic Energy. H. Poincaré 1154
Hittorf's Dark Space. H. Ebert 1897
Hysteresis. F. Niethammer 835
Hysteresis and Eddy Currents. A. Grau 473
Hysteresis, Effect of Temperature on. A. H. Thiessen 1736
Hysteresis Errors in Measuring Instruments. W. M. Stine 1036
Hysteresis at High Frequencies. I. Klemenčič 128
Hysteresis Loss for Small Induction. H. S. Webb 1927
Hysteresis at Low Temperatures. A. H. Ford 1925
Hysteresis in Magnetisation. C. Maurain 129
Hysteresis and Temperature. A. M. Thiessen 834
Incandescent Wires, Disintegration of. W. Stewart 7
Induction, *see* separate section.
Induction (Self and Mutual) *see* separate section.
Induction-Coil Condenser, Action of. A. G. Dell 119
Induction-Coil, High-Frequency. W. P. Boynton 120
Induction-Coil, Pressure of. A. Oberbeck 121
Induction-Coils. W. Hess 312
„ „ B. Walter 311
Inductoscripts. J. A. McClelland 996
Interrupter, Caldwell. A. G. Cooke 1918
Interrupter, Electrolytic. D'Arsonval 585
„ „ E. Lagrange 1178
„ „ A. Wehnelt 584
Interrupter for Induction-Coils. F. Dessauer 1182, 1183
Interrupter, Wehnelt. H. Armagnat 1519
„ „ A. Blondel 1184
„ „ J. Carpentier 1518
„ „ E. Hospitalier 1917
„ „ W. J. Humphreys 1916
„ „ A. Le Roy and others 1517
„ „ H. T. Simon 1919
„ „ P. Spies and A. Wehnelt 1521
„ „ E. Thomson 1181
Interrupter, Wehnelt, Theory of. H. T. Simon 1520
Interrupters, *see* also section Apparatus and Instruments (Electrical).
Iron and Nickel, Alloys of. F. Osmond 1203
Iron and Steel, Transformation of. H. le Chatelier 1837
Kathode Rays, *see* section Rays.
Larmor and Lorenz, Theories of. A. Liénard 267
Leyden Jars, Adjustable. S. Leduc 448
Lightning, *see* section Static Electricity.
Lorenz and Larmor, Theories of. A. Liénard 267
Luminosity and Electric Conductivity of Flames. A. Smithells, H. M. Dawson, and H. A. Wilson 574
Madagascar, Magnetic and Geodetic observations in. P. Colin 474
Magnetic Action, E.M.F. produced in Flame by. R. Blondlot 1527
Magnetic, Dielectro-, Media. V. Boccara and M. Pandolfi 1528
Magnetic Effect of Electrolytic Currents. S. Sheldon and G. M. Downing 305

For the **Explanation** of this Index see p. 909.

Abstract Nos.

Miscellaneous (Electricity and Magnetism), *continued.*
Magnetic Energy, Expressions of Maxwell and Hertz for. H. Poincaré 1154
Magnetic Field, Boiling-Points in. H. du Bois..... 1040
Magnetic Field, Deformation of Iron in. E. Rhoads 321
Magnetic Field, Effect of a Solid Conducting Sphere in, on the Magnetic Induction at a Point Outside. C. S. Whitehead..... 1700
Magnetic Field, Electrolytes in. H. Bagard..... 469
Magnetic Field, Electromotive Force on Mixing Liquids in. R. Blondlot 1733
Magnetic Field, Energy. H. Pellat.....318, 561
Magnetic Field, Motion of a Charged Ion in. J. J. Thomson 1896
Magnetic Field within a Tubular Current. W. de Nikolaieve 1923
Magnetic Field, Velocity of Light in. E. W. Morley, H. T. Eddy, and D. C. Miller..... 1667
Magnetic Force in Solenoids. C. C. Farr 1018
Magnetic Induction in Electrical Measuring Instruments. A. Campbell 831
Magnetic Induction in Iron Rods. J. L. W. Gill 1192
Magnetic and Meteorological Phenomena. v. Rijckevorsel 838
Magnetic Phenomena, Mechanical Illustration of. C. Weyher 319
Magnetic Polarisation of Quartz. A. Borel 1142
Magnetic Properties, Effects of Prolonged Heating on. S. R. Roget 590
Magnetic Properties of the Elements. S. Meyer 1529
Magnetic Properties of Hematite. A. Abt..... 1924
Magnetic Properties of Inorganic Compounds. S. Meyer 1922
Magnetic Properties and Low Temperatures. F. Osmond 1525
Magnetic Properties of Sheet Iron. W. Rohr 712
Magnetic Properties of Steel. Mme. Sklodowska-Curie..... 134
Magnetic Qualities of Iron, Standard Representation of. H. Kath ... 591
Magnetic Screening. C. Maurain..... 130
Magnetic Susceptibilities. J. Koenigsberger 324
„ „ E. Seckelson..... 471
Magnetic Susceptibility of Liquid Oxygen. J. A. Fleming and J. Dewar 470
Magnetic Susceptibility of Liquids. G. Jäger and S. Meyer 131
Magnetic Susceptibility of Water. G. Jäger and S. Meyer.....715, 836
Magnetic Transformation-point of Nickel Alloys. L. Dumas 1929
Magnetisation by Alternate Currents. M. Wien 322
Magnetisation, Circular, and Temperature, Effects of, on Longitudinally Magnetised Iron Wire. F. H. Pitcher 1522
Magnetisation of Crystals. A. Lutteroth 323
Magnetisation, Energy Dissipated in. C. Maurain 129
Magnetisation, Fall of, in Soft Iron. Lagrange..... 472
Magnetisation of Iron, Normal Curve of. W. S. Franklin and S. S. Clarke 1926
Magnetisation, Measurement of Changes Produced by. J. S. Stevens 135
Magnetisation, Momentary. W. Kaufmann 1735
Magnetisation, Plane, of Pyrrhotine. P. Weiss 713
Magnetised Bars, Constancy of. Mme. Sklodowska-Curie..... 133
Magnetism, Chemical Action of. E. Jahr 837
Magnetism and Conductivity of Iron. D. Korda..... 1041
Magnetism and Electricity. A. G. Webster 676
Magnetism in Ferro-Nickels. L. Houllevigue 1193
Magnetism and Molecular Rotation. Kelvin..... 1928
Magnetism, Terrestrial, *see* section Terrestrial Magnetism.
Magnetism, Theory of. H. du Bois..... 1042
Magnetism and the Thermoelectric Properties of Bismuth and its Alloys. G. Spadavecchia 1931
Magnetometer Observations and Atmospheric Pressure. G. Bellagamba 1933

For the **Explanation** of this Index see p. 909.

Miscellaneous (Electricity and Magnetism), *continued.* Abstract Nos.
Magneto-Optic Phenomena. J. G. Leathem 1139
Magnetostriction. H. Nagaoka and K. Honda 714
Magnets, Aged. A. Durward 132
Magnets, Bar. V. Guillet 1195
Magnets of Different Steels. A. Abt 833
Maxwell and Hertz, Expressions of, for Magnetic Energy. H. Poincaré 1154
Maxwell's Theory, Extension of. E. Edser 784
Medical Clinic, Electricity in 1249
Meters, *see* section Apparatus and Instruments.
Molecular Rotation and Magnetism. Kelvin 1928
Nickel Alloys, Magnetic Transformation-point of. L. Dumas 1929
Nickel and Iron, Alloys of. F. Osmond 1203
Nickel Steel. C. E. Guillaume 1523
Nickel Steels, Magnetic Properties of. E. Dumont 320
Nickels, Ferro-, Magnetism in. L. Houllevigue 1193
Permeability of Cast Iron, Effect of Silicon on. F. C. Caldwell 711
Photoelectric Currents. G. C. Schmidt 1212
Polarisation (Electric Waves), *see* separate section.
Polarisation (Electrolytic), *see* separate section.
Pyrites, Magnetic. G. Sagnac 1930
Pyrrhotine, Plane Magnetisation of. P. Weiss 713
Reaction-Velocity, Electrical. E. Cohen 1936
Residual Current, Theory of. E. Salomon 1052
Resonance, *see* separate section.
Sea, Detecting Objects at. H. Herberts 347
Solenoids, Magnetic Force in. C. C. Farr 1018
Specific Inductive Capacity, *see* section Capacity.
Static Electricity, *see* separate section.
Steel and Iron, Cast. B. S. Summers 1526
Steel, Magnetic Properties of. Mme. Sklodowska-Curie 134
Steels, Magnet. F. Osmond 1524
Telegraphy, *see* separate section.
Telephony, *see* separate section.
Terrestrial Magnetism and Electricity, *see* separate section.
Therapeutic Apparatus. W. J. Morton 1189
Therapeutic Use of Crookes Tubes. F. de Courmelles 1351
Thermal, Electro-, Relation. O. Wiedeburg 53
Thermal, Electro-, Relations. E. Riecke 299
Thermo-Electricity, *see* separate section.
Thévenin's Theorem. J. B. Pomey 1025
Tubes, Crookes, Circulation in. A. A. C. Swinton 82
Tubes, Crookes, Therapeutic Use of. F. de Courmelles 1351
Tubes, Vacuum. L. Bonetti 81
Tubes, Vacuum, Energy Consumed in. H. Ebert 684
Tubes, Vacuum, Potential Gradients in. E. Wiedemann and G. C. Schmidt 280
Tubes, Vacuum, Variation of Gaseous Pressure in. G. Séguy 80
Units, Electrical, Dimensions of. K. Schreber 1702
Voltaic Action, *see* section Batteries (Primary).
Waves, *see* section Radiation.
Wattmeter, Correcting Factor of. F. Loppé 116
Wimshurst Machines. S. Leduc 447
X-Rays, *see* section Rays.

Miscellaneous (General Electrical Engineering).
Accessories and Appliances, *see* separate section.
Aluminium, Solder for 162
Auxiliary Plant at Bristol, Electrically Operated. H. F. Proctor 200
Batteries, *see* separate sections.
Bearing, Hyatt Roller 1080
Bicycle-Steering, Theory of. G. T. McCaw 652

For the **Explanation** of this Index see p. 909.

Abstract Nos.

Miscellaneous (General Electrical Engineering), *continued.*

Blast Furnaces, Power from. A. Witz 1258
Boilers, Steam, Installation of 1970
By-Products of Power Plants. M. M. Fenner 615
Carbon-Dioxide Motor 496
Carbons 1564
Carbons, Manufacture of. F. Jehl 169, 893
Chicago Public Library, Electric Dumb Waiters in the 610
Cloth, Hot pressing of. C. Mouchel 901
Coal Handling Machinery 498
Coals, Weathered. R. S. Hale and H. J. Williams 499
Condensers for Electric Stations. J. F. C. Snell 1773
Cost of Steam and Water Power. W. O. Webber 358
Crane, Electric 891
" " W. A. Post 1261
Cranes, Electric, at Southampton Harbour 611
Cranes and Elevators. G. Richard 1423
Draft, Mechanical. W. B. Snow 350
Dumb Waiters, Electric, in the Chicago Public Library 610
Efficiency, Thermal, of Steam Engines 178
Elevator, Reno Inclined 174
Elevators for Central London Railway 1259
Elevators and Cranes. G. Richard 1423
Elevators, Electric. A. E. B. Ridley 1078
Elevators in the Ivin's Building, New York 1424
Engine-Power Gauge. G. F. Atwood 494
Engines, Gas. E. Ruud 1260
Engines for Power Stations. C. E. Emery 495
Engraving Machine, Electric. F. J. Patten 1966
Feed-Pump Test. F. M. Wheeler 1077
Fuel, Oil 177
Fuel, Waste of. F. Bruton 1081
Gas Engines. E. Ruud 1260
Governor, Shaft. T. Hall 176
Heating Apparatus, Electric. J. Reyval 743
Heating Apparatus, Electrical. R. B. Ritter 171
Heating Apparatus, Parvillée Electric. J. Reyval 903
Heating, Electric 1568
Horse-Power, Measure of 1422
Hot Pressing of Cloth. C. Mouchel 901
Hyatt Roller Bearing 1080
Injectors, Boiler-feeding by. J. Whitcher 349
Insulation and Insulators, *see* separate section.
Library, Public, Chicago, Electric Dumb Waiters in the 610
Lifts for New Brighton Tower 907
Magnetic Concentration Plant, Trustedt's 1411
Machine Tools, *see* separate section.
Mechanical Applications of Electricity. G. Richard 1769
Mechanical Resistance of Air. O. Mannesmann 404
Meters, *see* section Apparatus and Instruments.
Motor, Carbon-Dioxide 496
Printing by X-Rays 1256
" " F. S. Kolle 1257
Printing Office, Motors in. C. A. Dresser 1425
Pumps. F. Neesen 1461
Refrigerating Plant, Equipment of 1092
Refrigeration, Electrical. T. F. Fay 612
Rails, Steel, Wear of. A. T. Moxham 530
Reno Inclined Elevator 174
Seasoning Timber, Electric 1082
Siren, Electric. D. H. Keeley 1427

For the **Explanation** of this Index see p. 903.

Abstract Nos.

Miscellaneous (General Electrical Engineering), *continued.*
Sleepers, Old Rails as 631
Sleepers, Preservation of. W. H. Glenn 633
Solder for Aluminium 162
Steam Engine, Simple, with Remarkable Economy 1971
Steam Engines, Thermal Efficiency of 178
Steam, Exhaust, Utilisation of. M. M. Fenner 615
Steam, Flow of, through Pipes. R. C. Carpenter and E. C. Sickles... 1428
Steering-gear. J. Fischer-Hinnen 492
Steering Torpedoes by Hertz Waves 1567
Switch, Automatic 889
Thawing Water-Pipes with Electricity 1965
Timber Seasoning, Electric 1082
Torque, Measuring. Boucherot 745
Torpedoes, Steering, by Hertz Waves 1567
Train Resistance. J. B. Blood 1303
„ „ H. Graftio 1596
Trustedt's Magnetic Concentration Plant 1411
Turntable "Donkey," Electric 348
Turntable, Electrically Driven 607
Vats and Cells (Electrolytic), see separate section.
Windmills, Electric Power from. C. L. Crandall 1818
Wool Removed from Skins Electrically 1967

Miscellaneous (General Physics).
Air Jets. L. Mach 8
Air, Mechanical Resistance of. O. Mannesmann 404
Air Waves due to Projectiles. Obermayer 9
Aluminium, Applications of. H. Moissan 1532
Aluminium, Progress of 1065
Aluminium, Solder for 162
Arc of the Meridian, Measurement of an. Bassot 1636
Astronomy, *see* separate section.
Atmosphere, Temperature and Vapour Gradients in the. F. H. Bigelow 1644
Atmospheric Tides. F. Morano 1638
Balances, Oscillations of. D. Mendeléeff 6
Balloons, Exploring-. A. Bouquet de la Grye 1123
Barometers, Aneroid. C. Chree 1115
Barometric Charts, Lunar Influence on. A. Poincaré 1640
Beams, Continuous. H. J. Tomlinson and K. Pearson 493
Biological Thermodynamics. A. Chauveau 1691
Blind, Relief-Pictures for. Dussaud 236
Caoutchouc, Physical Properties of. A. E. Lundal 230
Capillarity, *see* section Surface Tension.
Central Motions. P. Stäckel 1121
Cohesion of Mercurial Columns. A. Pizzarello 401
Copper, Ductility of. H. Bouasse 539
Copper, Mechanical Properties of. M. Rudeloff 772
Critical Constants, *see* section Critical Points.
Crystals, Directive Action of one on another. J. H. Poynting and P. L. Gray 777
Curvature of Surfaces. B. Wanach 1628
Deformation, see section Elasticity.
Densities, Solution. H. T. Barnes and A. P. Scott 398
Density and Ductility. L. Grunmach 399
Density of Ice. E. L. Nichols 397
Density of Liquids and Saturated Vapours. C. del Lungo 60
Density and Molecular Weight of Fluids. D. Berthelot 541
Density of Solutions, Maximum. L. C. de Coppet 1626
Ductility of Copper. H. Bouasse 539
Ductility and Density. L. Grunmach 399

For the **Explanation** of this Index see p. 909.

Abstract Nos.

Miscellaneous (General Physics), *continued.*
Earth, Density of the. F. Richarz and O. Krigar-Menzel 1467
Earth Tremors and Mercury Reflectors. G. Bigourdan..... 1468
Earthquake in Hayti. G. Agamennone 416
Earthquakes. A. Cancani 781
Earthquakes in Labuan. G. Agamennone 415
Elasticity, *see* separate section.
Energy, Potential and Kinetic. E. Merritt 413
Ether and Absolute Velocity. O. Lodge 653
Ether, Inertia as a Manifestation of. C. Barus..... 654
Ether, Motions of the. G. Mie 1323
Expansion, *see* section Dilatation.
Explosion-waves, Collision of two. R. H. Jones and J. Bower..... 408
Films, Liquid, Least Thickness of. K. T. Fischer 1625
Films, Liquid, Spreading of. J. Stark..... 10
Films, Liquid, Thickness of the Black Spot in. E. S. Johonnott, Jr. 1338
Flow Structures. K. Mack..... 1462
Fluid Motion. H. S. Hele-Shaw 978
Fluids, Characteristic Equation for. E. H. Amagat 1007
Flying. M. F. Fitzgerald 1325
Fog and Electricity. A. Garbasso 449
Friction, Molecular Theory of. M. Brillouin 977
Geodesy in France. Bassot 1124
Glass, Aqueous Fusion of. C. Barus 1045
Gravity, *see* separate section.
Harmonic Motion. C. Barus..... 1117
Horizon, Apparent, Variations. F. A. Forel 1842
Hydrodynamics. E. W. Brown 648
Hydrogen, Free, in Air. A. Gautier 477
Ice, Slipperiness of. O. Reynolds 1322
Impact with a Liquid Surface. A. M. Worthington and R. S. Cole 1624
Inertia as a Manifestation of the Ether. C. Barus 654
Instrument-Reading. F. G. Baum 1114
Interpretation of Results. E. Vallier 649
Iron, Wrought, at High and Low Temperatures. R. C. Carpenter... 1621
Jets, Air. L. Mach 8
Joule's Law, Gases which obey. F. Carré 807
Kinetic and Potential Energy. E. Merritt 413
Kinetic Theory of Liquids. C. Dieterici 263
" " " W. Voigt 1882
Lamp Filaments, Incandescent, Effect of Fire-damp on. H. Couriot and J. Meunier 608
Liquid and Solid, Transition between. G. A. Hulett 1392
Liquids, Kinetic Theory of. C. Dieterici 263
" " " W. Voigt 1882
Liquids and Saturated Vapours, Density of. C. del Lungo 60
Liquids with Unassociated Molecules (Part II.). G. Bakker..... 59
Madagascar, Magnetic and Geodetic Observations in. P. Colin 474
Mercurial Columns, Cohesion of. A. Pizzarello 401
Metals, Physical Properties of. H. F. Parshall and H. M. Hobart... 981
Meteorology, &c., *see* separate section.
Micrometers, Correction of, by Interference. M. Hamy 2
Mirages and Tornadoes, Artificial. R. W. Wood..... 1629
Molecular Theory of Friction. M. Brillouin..... 977
Motion, Fluid. H. S. Hele-Shaw..... 978
Motion, Variations of a System in. Natanson 1324
Muscular Action. Z. Treves 412
Muscular Elasticity. A. Chauveau 411
Newton's Third Law of Motion. P. Volkmann 231
Nutations and Forced Precession of an Ellipsoidal Shell. W. McF. Orr 414

For the **Explanation** of this Index see p. 909.

Abstract Nos.

Miscellaneous (General Physics), *continued.*
Orbital Motion, Magnetic Reproduction of. R. W. Wood 20
Passive State of Iron and Steel. L. Houllevigue 141
Pendulum, Elasticity of a. E. Almansi 1460
Pendulum Motion, Maintenance of. A. Guillet 5
„ „ „ G. Lippmann 4
Physiological Action of Alternating Currents. J. L. Prevost and F. Battelli 651
Pole, Terrestrial, Movement of. E. F. Van de Sande Bakhuyzen ... 1645
Potential and Kinetic Energy. E. Merritt 413
Precession, Forced, and Nutations of an Ellipsoidal Shell. W. McF. Orr 414
Projectiles, Air Waves due to. Obermayer 9
Reading, Instrument. F. G. Baum 1114
Resistance, Mechanical, of Air. O. Mannesmann 404
Resistance, Train. J. B. Blood 1303
„ „ H. Graftio 1596
Results, Interpretation of. E. Vallier 649
Rigidity, *see* section Elasticity.
Seismic Movements, Influence of Moon on. U. Landi 1466
Seismograph, Micro-. T. Gnesotto 1635
Seismometrographs. A. Cancani 1634
Steam Jet, Blue. H. Bock 1852
Surface Tension, *see* separate section.
Terrestrial Pole, Movement of. E. F. Van de Sande Bakhuyzen 1645
Tidal Problem, Solution of the. J. F. Hayford 779
Time, Absolute Measurement of. G. Lippmann 1463
Tornadoes and Mirages, Artificial. R. W. Wood 1629
Torsion, *see* section Elasticity.
Tubes, Crookes, Therapeutic Use of. F. de Courmelles 1351
Vacua, High, by Liquid Hydrogen, with their spectroscopic examination. J. Dewar 592
Vibrating Wire, Period and Decrement of a. J. O. Thompson 1118
Vibration of Apparatus. A. Broca 537
Viscosity of Gases. P. Breitenbach 775
Viscosity of Liquids. G. Tammann 1111
„ „ G. Wetzstein 1623
Waves, Air, due to Projectiles. Obermayer 9
Wire, Vibrating, Period and Decrement of. J. O. Thompson 1118

Miscellaneous (Heat).
Atmosphere, Temperature and Vapour Gradients in. F. H. Bigelow 1644
Boiling-Points, *see* section Freezing-Points.
Calorie, Regnault's, and the Specific Volumes of Steam. G. P. Starkweather 1008
Calorimetry. S. Lussana 1875
Conductivity (Thermal) *see* separate section.
Convection, Diffusive. A. Griffiths 406
Convection, Diffusive, Source of Energy in. A. Griffiths 1318
Critical Points and Constants, *see* separate section.
Dilatation, *see* separate section.
Dilution, Thermal Effects of. J. H. Pollok 1396
Dulong and Petit's Law. F. Richarz 1363
Emissivity of Platinum. J. E. Petavel 1017
Endothermic Gases. W. G. Mixter 1389
Expansion, *see* section Dilatation.
Flame Temperatures. F. Berkenbusch 670
Flames, Electric Conductivity and Luminosity of. A. Smithells, H. M. Dawson, and H. A. Wilson 574
Freezing-, Melting-, and Boiling-Points, *see* separate section.
Fusion, Heat of. G. Tammann 1150

For the **Explanation** of this Index see p. 909.

Abstract Nos.

Miscellaneous (Heat), *continued.*
Fusion, Pressure and Temperature of. Demerliac 801
Gases and Vapours, *see* separate section.
Glass, Aqueous Fusion of. C. Barus 1045
Glass, Tempering. L. Marchis 1490
Heat Latent, *see* section Specific Heat.
Heat, Propagation of. G. Lauricella 58
Heat, Specific, *see* section Specific Heat.
Heat, Transmission of through Plates. G. Haliday 57
Heat-waves, Long. H. Rubens and E. Aschkinass 553
Incandescent Wires, Disintegration of. W. Stewart 7
Iron and Steel, Transformation of. H. le Chatelier 1837
Kirchhoff's Law. A. Cotton 1851
„ „ W. Voigt 1016
Latent Heat, *see* section Specific Heat.
Luminosity and Electric Conductivity of Flames. A. Smithells, H. M. Dawson, and H. A. Wilson 574
Mechanical Equivalent of Heat. O. Reynolds and W. H. Moorby ... 52
„ „ „ C. W. Waidner and F. Mallory ... 1366
Mechanical Equivalent of Heat and Specific Heats of Gases. A. Leduc 261
Melting-Points, *see* section Freezing-Points.
Molecular Volumes. A. Leduc 1491
Radiometers, Pressure in. E. Riecke 1853
Recalescence, Length-Variation of Iron and Steel during. G. E. Svedelius 1
Recalescence and Torsion of Steel. G. Moreau 538
Steam, Specific Volumes of, and Regnault's Calorie. G. P. Starkweather 1008
Steel, Torsion and Recalescence of. G. Moreau 538
Temperature, *see* separate section.
Temperatures (High and Low) *see* separate section.
Temperatures, High, by means of Aluminium. H. Goldschmidt 1950
Thermal, Electro-, Relation. E. Riecke 299, 1024
„ „ „ W. Voigt 822
„ „ „ O. Wiedeburg 53
Thermodynamics, *see* separate section.
Thermometer, Air. L. Holborn and A. Day 1873
Thermometer, Aspiration. P. Fuchs 805
Thermometer Zero Points and Glass, Temperature Changes of. L. Marchis 1686
Thermometers, Jena Glass. H. Lemke 1361
Thermometric Corrections. F. Grützmacher 1872
Thermometric Fixed Point and Normal Temperature. W. Meyerhoffer and A. P. Saunders 1009
Thermometric Fixed Points, Transition-temperatures as. T. W. Richards and J. B. Churchill 1010
Thermometry, Platinum. H. L. Callendar 1011
„ „ E. B. H. Wade 1012
Vapour Pressure, *see* separate section.

Miscellaneous (Light).
Aberration in Astronomical Telescopes. H. Harting 1656
Aberration, Corrections for. R. Steinheil 1846
Absorption, *see* separate section.
Blue Steam Jet. A. Bock 1852
Bravais Points. P. Lefèvre 1850
Brightness of Sources of Light. P. Jenko 994
Colour, Apparent. W. B. Lane 1132
Colour of Iodine Vapour. J. Dewar 785
Colour Measurement. T. E. Doubt 240
Colour, Recent Views on. A. H. Abbot 788

For the **Explanation** of this Index see p. 909.

Miscellaneous (Light), *continued.* Abstract Nos.
Condensation Nuclei. C. T. R. Wilson 662
Crookes Tubes, *see* Tubes, Crookes (Miscellaneous section, Electricity).
Crystal, Optical Constants of a. C. Viola 1652
Crystals, Characteristics of. C. Leiss 1651
Diffraction, *see* section Interference.
Dispersion, *see* separate section.
Faraday Effect in Salt Solutions. S. Oppenheimer 658
Films, Liquid, Thickness of the Black Spot in. E. S. Johonnott, Jr... 1338
Fizeau's Researches. A. Cornu 12
Fluorescence, *see* section Phosphorescence.
Garnet, Optical Characteristics of. C. Klein 1135
"Green Ray" after a Red Sunset. Guébhard 1646
Illumination, Determining. L. Hoest 791
Images, Prismatic. R. Straubel 243
Incandescent Mantle, Theory of. Bunte 242
Index of Reflection, *see* section Reflection.
Index of Refraction, *see* section Refraction.
Interference, *see* separate section.
Iodine Vapour, Colour of. J. Dewar 785
Kathode Rays, *see* section Rays.
Kirchhoff's Law. A. Cotton 1851
" " W. Voigt 1016
Light, Brightness of Sources of. P. Jenko 994
Light, Dark. G. le Bon 548
Light, Effect of Medium upon Wave Form of. W. Voigt 1670
Light at Low Temperatures. A. and L. Lumière 1129
Light, Monochromatic, as a Damped Vibration. A. Rovida 1336
Light, Monochromatic, Source of. C. Fabry and A. Perot 1470
Light, Physical Effects of. M. Roloff 140
Light, Transmission of, through an Atmosphere containing Small Particles. Rayleigh 1655
Light, Transmission of, through Turbid Media. P. Compan 1133
Light, Velocity of, in a Magnetic Field. E. W. Morley, H. T. Eddy, and D. C. Miller 1667
Luminescence, Thermodynamics of. E. Wiedemann 1014
Luminosity and Electric Conductivity of Flames. A. Smithells, H. M. Dawson, and H. A. Wilson 574
Magneto-Optic Phenomena. J. G. Leathem 1139
Microscope, Interference. E. Pringsheim 995
Microscope, Theory of the. K. Strehl 1137
Mirages and Tornadoes, Artificial. R. W. Wood 1629
Mirrors, Ancient. Berthelot 650
Mirrors, Gold and Platinum. G. Breithaupt 1329
Mirrors, Light Plane. A. Mallock 1326
Monochromatic Illumination. R. Straubel 245
Monochromatic Light as a Damped Vibration. A. Rovida 1336
Monochromatic Light, Source of. C. Fabry and A. Perot 1470
Nuclei, Condensation. C. T. R. Wilson 662
Objective, Photographic, Distribution of Light on the Focal Plane. M. von Rohr 244
Objective, Telescopic, for Spectroscopic Use. C. S. Hastings 1472
Objectives, Astronomical Telescope. H. Harting 1844
Objectives, Compound. H. Harting 787
Objectives, Fraunhofer's. H. Krüss 1328
Objectives of Small Aperture. H. Harting 786
Objectives, Telescope. E. v. Höegh 1327
Optical Phenomena, Illustrations. J. D. Everett 237
Optical Systems, Singular Points in. P. Lefèvre 1130
Oscillations, *see* separate section.

For the **Explanation** of this Index see p. 909.

Abstract Nos.

Miscellaneous (Light), *continued.*
Phosphorescence and Fluorescence, *see* separate section.
Photoelectric Currents. G. C. Schmidt 1212
Photography, *see* separate section.
Photometry, *see* separate section.
Polarisation, *see* separate section.
Prism, Reversing. B. Wanach..... 1847
Prismatic Images. R. Straubel..... 243
Quartz Plate Normal to the Axis. R. Dongier 656
Radiation, *see* separate section.
Rays, *see* separate section.
Reflection, *see* separate section.
Reflectors, Mercury, and Earth Tremors. G. Bigourdan 1468
Refraction, *see* separate section.
Reversing Prism. B. Wanach 1847
Röntgen Rays, *see* section Rays.
Rotatory Polarisation, *see* section Polarisation.
Sellmeier's Theory. Kelvin 1672
Siderostat, Paris Exhibition. P. Gautier..... 1845
Singular Points in Optical Systems. P. Lefèvre 1130
Spectra, *see* separate section.
Spectroscope of Fixed Deviation. P. Pellin and A. Broca..... 1865
Spectroscope, Stellar. S. A. Mitchell 1864
Spectroscopes, Efficiency of. H. C. Lord 1863
Speculum, Large. P. Gautier..... 1657
Sunset, Red, "Green Ray" after a. Guébhard..... 1646
Transparency, *see* section Absorption.
Tremors, Earth, and Mercury Reflectors. G. Bigourdan 1468
Turbid Media, Transmission of Light by. P. Compan 1133
Vacua, High, by Liquid Hydrogen, with their Spectroscopic Examination. J. Dewar 592
Water Optically Uniform. A. Battelli and M. Pandolfi 1653
Waves, *see* separate section.
X-Rays, *see* section Rays.
Zeeman Effect and Radiation in a Magnetic Field, *see* separate section.

Miscellaneous (Power Transmission, Traction and Lighting).
Accessories, *see* separate section.
Accumulators, *see* section Batteries.
Allen and Peard's Mechanical Contact System 630
Axles, Breakage of. J. F. Thompson 1299
Blast Furnaces, Power from. A. Witz 1258
Cables, *see* separate section.
Carborundum Company, Transformer Equipment. J. S. Peck 916
Cars, *see* Traction.
Central Station Design. B. J. Arnold 948
Circuit Breaker, La Roche 888
Coal-Mines, Electricity in. H. N. Gardner 1960
Conductors, Networks of, of Finite Transverse Dimensions. J. B. Pomey 1703
Conductors and Wiring, *see* separate section.
Cost of Electric Energy, &c., *see* separate section.
Cost of Steam and Water Power. W. O. Webber 358
Design, Central Station. B. J. Arnold..... 948
Docks and Harbours, Electrical Plant for. J. D. W. Aldridge 513
Drawbridge Contact, Electric. E. T. Birdsall 1569
Drawbridge, Electrically Operated. W. Kidde..... 905
Electricity Works (Descriptive), *see* separate section.
Engines for Power Stations. C. E. Emery 495
Erecting a High Pressure Transmission Line. S. H. Dailey..... 613
Lamps (Arc), *see* separate section.
Lamps (Incandescent), *see* separate section.

For the **Explanation** of this Index see p. 909.

Abstract Nos.

Miscellaneous (Power Transmission, Traction and Lighting), *continued.*
Lighting of Country Houses. B. M. Drake 1104
Marine Propulsion, Electric Power for. C. T. Child 1771
Mechanical Applications of Electricity. G. Richard 1769
Mechanical Resistance of Air. O. Mannesmann 404
Meters, *see* Apparatus and Instruments.
Mining, Electric Power in. J. McGhie 904
Mining, Transmission in. W. B. Esson 921
Parvillée Electric Heating Apparatus. J. Reyval 903
Plant, Central Station, Utilisation of. A. Meynier 1437
Power Transmission and Distribution, *see* separate section.
Printing, Electricity in. G. A. Damon 512
Printing Office, Motors in. C. A. Dresser 1425
Pumping, Electric, in Mines 1772
Pumps, Electric, Efficiency of 1079
Rails, Steel, Wear of. A. T. Moxham 530
Refrigeration, Electrical. T. F. Fay 612
Reno Inclined Elevator 174
Semaphore, Electric Motor. F. Křižik 1770
Ship, Electricity on Board. S. D. Greene 759
Signal Boards, Luminous. K. B. Miller 393
Sleepers, *see also* Ties.
Sleepers, Old Rails as 631
Sleepers, Preservation of. W. H. Glenn 633
Steam Engines, Electric Light and Traction 1972
Steel-Making, Electric Power in. E. B. Clark 1969
Steel Works, Electricity in 906
Survey, Electrical, in New York. A. A. Knudson 899
Swing-Bridge Crossing. E. Dieudonné 365
Synchroniser for Three-Phase Plant 892
Synchronisers for Three-Phase Generators. H. Müller 1774
Torpedo Vessels, Electricity on. B. Pontifex 531
Track Construction. T. H. Gibbon 632
Traction (Electric, by Accumulators), *see* separate section.
Traction (Electric, by Trolley, Conduit, or Contact, &c.), *see* separate section.
Traction (Mechanical), *see* separate section.
Train Lighting 390
Train Resistance. J. B. Blood 1303
" " H. Graftio 1596
Trains, Intercommunication in. W. E. Langdon 746
Vehicles, Electric, and their Relation to Central Stations. H. M. Maxim 902
Vessels, American, Electricity on. J. McGhie 1570
Windmills, Electric Power from. C. L. Crandall 1818

Motors.
Alternate Current Motors. C. F. Guilbert 1577
Alternating Current Motors. E. J. Berg 1087
Alternating Currents, Motors for. G. Moulun 752
Braking Induction Motors. F. Eichberg 755
Capacities, Dynamo and Motor. A. D. Adams 1274
Coupling of Motors by Görges Phenomenon. F. Eichberg 753
Crocker-Wheeler Motors for Special Purposes 1975
Diagrams, Motor. C. C. Hawkins 915, 1277
Fan Motors 1434
Görges Phenomenon and Coupling of Motors. F. Eichberg 753
Headland's Motor for Vehicles 1578
Induction Motors. W. Baxter, Jr. 1088
" " T. Marcher 1276
" " A. E. Wiener 355
" " E. Wilson. Also Field and W. M. Mordey 1275

For the **Explanation** of this Index see p. 909.

Abstract Nos.

Motors, *continued.*
Induction Motors, Theory of. J. Heubach 1976
„ „ „ G. Ossanna..... 1781
Langdon-Davies Single-Phase Motor 754
Monophase Motors. G. B. Maffiotti and F. Pescetto 912
Motors in a Printing Office. C. A. Dresser 1425
Pumps, Electric, Efficiency of 1079
Railway Motor, Walker 504
Railway Motors, Electric. G. T. Hanchett 187
Railway Motor, Electric. C. T. Hutchinson..... 1810
Regulation by Leading and Lagging Currents 919
Regulation of Motors. R. E. Menges..... 186
Resistances, Starting and Braking, for Traction Motors. F. Erens... 1767
Rotary Field Motors. S. Hanappe 185
Single-Phase Motors..... 914
Slip in Induction Motors. M. v. Hoor 1579
Slip of Induction Motors. E. Rosenberg 1780
Speed of Alternate Current Motors. W. G. Rhodes 1089
Speed, Controlling. F. A. Johnson 1278
Starting Devices. C. F. Guilbert 756
Vehicles, Headland's Motor for..... 1578

Osmosis.
Ether Solutions, Osmotic Pressure in. H. M. Goodwin and G. K. Burgess 480
Osmotic Pressure. F. Barmwater 1224
„ „ A. Ponsot 1540
Osmotic Pressure and Osmotic Work. C. Dieterici 1541
Osmotic Pressure and Thermodynamics. N. Schiller..... 722
Osmotic Theory of Galvanic Cell. W. Nernst and E. Bose 863
Osmotic Wind. K. Schreber..... 1225
Osmotic Work and Pressure. A. A. Noyes 1223

Phosphorescence and Fluorescence.
Absorption, Change of, produced by Fluorescence. J. Burke 1350
Balmain Luminous Paint. L. Kann..... 1349
Electroluminescence and Absorption of Electric Waves. H. Kauffmann 1499
Fluorescence in Crookes Tubes. P. Villard 438
Fluorescence, Polarised. G. C. Schmidt..... 1869
Light at Low Temperatures. A. and L. Lumière 1129
Luminiscence, Residual. G. le Bon 550
Phosphorescence. H. Jackson..... 439
Phosphorescence at Low Temperatures. A. and L. Lumière 551
Phosphorescence of Strontium Sulphide. J. R. Mourelo 552
Rare-Earths, Luminosity of. A. A. C. Swinton..... 1683
Solid Solutions, Fluorescent. J. R. Mourelo 1145
Thermodynamics of Luminescence. E. Wiedemann 1014
Triboluminescence. W. J. Pope 1680

Photography.
Colour-Photographs, Diffraction. R. W. Wood 1664
Colour-Photography, Joly Process. J. S. Gibson 30
Coloured Photographs. L. Delvalez 31
Colson-Russell Photographic Effect. J. H. Vincent 1681
Daguerreotype as an Interference Process. H. Scholl 1474
Daguerreotypes, Interference Fringes on. O. Wiener 1473
Electric Currents, Action of, on Photographic Plates. E. Jahr..... 984
Gases and Metals, Action of. B. von Lengyel 256
Living Structures, Action of. P. Frankland 255
Photographic Action by Röntgen Rays, *see* section Rays.
Photographic Plates, Restoration of. E. Andréoli 1335

Photometry.
Amyl Acetate Standard Lamp. W. M. Stine..... 1662
Arc Light Formulæ. W. Harkness 952

For the **Explanation** of this Index see p. 909.

Abstract Nos.

Photometry, *continued.*
Arc Light Photometry. C. P. Mathews, W. H. Thompson, and J. E. Hilbish 951
Flicker Photometer. O. N. Rood 26
„ „ F. P. Whitman 28
Flicker Photometer and Colour-Blindness. O. N. Rood 27
Illumination, Measurement. Onimus 241
Methven Standard. R. A. Fessenden 1127
Photometer. J. Hartmann 1660
Photometer, Actino. C. Henry 1661
Photometer, Self-Correcting. B. Speed 1659
Photometric Readings, Recorder. C. P. Mathews 542
Photometric Standard. C. Féry 19
Photometric Standards. F. Laporte 789
Standards of Light. A. Blondel 417

Polarisation (Electrolytic).
Polarisation. W. A. Anthony 700
„ Heim 107
„ H. Jahn 302
Polarisation in Alkaline Sulphates. H. Jahn 1506
Polarisation Capacities. A. M. Scott 579
Polarisation and Internal Resistance of Cells. K. E. Guthe 578
Polarisation of thin Metallic Foil. G. P. Grimaldi and G. Platania 580
Polarisation under Pressure. A. Chassy 698
„ „ „ R. Federico 466, 699
Residual Current, Theory of. E. Salomon 1052
Reversible Electrodes. E. Neumann 708
Unpolarisable Electrodes. E. Warburg 707
Water, de-ærated, Polarisation of. R. Federico 1725

Polarisation (Light).
Blue Steam Jet. A. Bock 1852
Crystalline Polarisation, Kinetic Theory of. J. Beckenkamp 657
Faraday Effect in Salt Solutions. S. Oppenheimer 658
Magnetic Polarisation of Quartz. A. Borel 1142
Magnetic Rotatory Polarisation. H. Becquerel 246
Mixtures of Optical Isomers. G. Bruni 1402
Molecular Rotatory Power. H. Pottevin 1856
Optical Activity of Gallotannic Acid. O. Rosenheim and P. Schidrowitz 1400
Optically Active Alkyloxypropionic Acids. T. Purdie and G. D. Lander 1399
Polarisation of Diffused Light. A. Lafay 1339
Polarisation by Total Reflection. R. Geigel 1855
Rotary Dispersion. G. V. Wendell 998
Rotatory Polarisation of Malic Acid. L. Kann 1141
Rotatory Power of Electrolytes. E. Rimbach 997
Rotatory Power of Quartz. R. Dongier 23
Rotatory Power of Sugar. E. Mascart and H. Bénard 1401
Velocity of Light in a Magnetic Field. E. W. Morley, H. T. Eddy, and D. C. Miller 1667

Power Transmission and Distribution.
Accumulators, Applications of. J. Appleton 947
Alternate Current Distribution. H. A. Wagner 197
Alternating and Direct Current Distribution. L. A. Ferguson 198
Alternating Currents, Distribution by. S. E. T. Ewing 763
Blast Furnaces, Power from. A. Witz 1258
Brooklyn Electric Supply System. W. S. Barstow 1706
Coal-Mines, Electricity in. H. N. Gardner 1960
Central Station Plant, Utilisation of. A. Meynier 1437
Combined Telephone and Electric Light Stations. H. P. Clausen 300
Condensers in Alternate Current Transmission. L. Lombardi 1585

For the **Explanation** of this Index see p. 909.

Abstract Nos.

Power Transmission and Distribution, *continued.*
Constants for Power Transmission 1426
Distribution, Direct and Alternating Current. L. A. Ferguson..... 198
Docks and Harbours, Electrical Plant for. J. D. W. Aldridge 513
Electric Motive Power in Small Industries. A. H. Gibbings..... 202
Electrical Transmission. P. Janet 359
Electrical Transmission of Energy. A. Siemens 201
Feeder System at Boston, U.S.A. 1977
Granada, Transmission at. R. B. Ritter 766
Hamilton, Ontario, Transmission at 767
Hartford, Rotary Transformers and Storage with Long-Distance Transmission at. W. L. Robb 1794
High-Pressure Lines, Erection of. S. H. Dailey 173
High-Voltage Transmission. F. Scott 764
Kootenay-Rossland Power Transmission. G. P. Low..... 1586
Les Clees-Yverdon, Transmission of Electrical Energy at. J. Laffargue 196
Lighting and Traction Works, Combined. J. H. Rider 1798
London, Electricity Supply of. A. H. Preece 1795
Long-distance Power Transmission. E. J. Berg 194
Long Transmission Lines, Problems in. F. Breisig..... 1791
Midland Railway, Electric Light and Power on the. W. E. Langdon 203
Mines, Electricity in Coal-. H. N. Gardner 1960
Mining, Transmission in. W. B. Esson 921
Multiphase Systems. W. S. Kelley 509
Niagara. Plant at. J. E. Woodbridge 924
Polyphase Distributing Systems. T. Marcher 920
Polyphase Distribution. V. Spagnuolo 360
„ „ G. Stern 1584
Polyphase Generation 1575
Polyphase Transmission. F. Wallis..... 761
Power Transmission. G. Forbes 760
Pressure Regulation in Long-distance Transmission. E. J. Berg..... 195
Regulation by Leading and Lagging Currents 919
San Gabriel Los Angeles Transmission. G. P. Low..... 923
Secondary Circuits, Design of. G. L. Thayer 918
Ship, Electrical Machinery on Board. A. Siemens 1963
Ship, Electricity on Board. S. D. Greene 759
Short Distance Power Distribution. J. Swinburne 1793
Small Output, Electricity Works. A. D. Adams 1978
Snoqualmie Falls Transmission Plant 516
Switzerland, Electrical Engineering in 1800
Three-Phase Four-Wire System. A. J. Bowie 1790
Three-Phase Installation at Bristol. W. Geipel 363
Three-wire Systems, Pressure Regulation in. C. del Proposto..... 623
Transformer, Alternating Current. W. F. White..... 189
Transmission Line, Erecting a High Pressure. S. H. Dailey 613
Two-Phase Currents in New York. E. A. Leslie 1789
Two-wire Distribution. J. W. Howell 199
Vessels, American, Electricity on. J. McGhie 1570
Vienna Five-Wire Systems. J. Kolbe 1589
Water-Power in Italy. E. Bignami 1587
Workshop, Electrically Driven, of the A. E. G. 1961
Workshop Transmission 922
Workshops, Power in. C.M.Barber. Also C.H.Benjamin and Sherwood 1281
„ „ H. A. Mavor 1282

Radiation, Waves, Oscillations (*see also* Rays, Resonance and Discharge).
Bolometers. S. P. Langley 54
Coherer-Sparks. R. Malagoli 458
Coherers, *see* also section Miscellaneous Electricity and Magnetism.
Coherers. E. Aschkinass 292
„ O. Behrendsen 293

For the **Explanation** of this Index see p. 909.

Abstract Nos.

Radiation, Waves, Oscillations (*see also* Rays, Resonance and Discharge), *continued.*

Coherers, Materials for. E. Dorn 106
Coherers, Theory of. D. van Gulik 105
Dispersion, Electric. K. F. Löwe 288
„ „ E. Marx 289
Distant Mechanism, Control of 898
Emission Function, Constant. F. Paschen and H. Wanner 1138
Heat-Waves, Long. H. Rubens and E. Aschkinass 553
Hertz Experiments. J. Precht 286
Hertzian Field in Air and in Oil. A. Turpain 91
Hertzian Field in Air and in Water. A. Turpain 569
Hertzian Oscillations. O. Murani 1905
Hertzian Oscillations and Metal. E. Branly 90
Hertzian Oscillations, Phase of. M. Abraham 819
Incandescent Gas Mantles, Radiation from. H. le Chatelier and O. Boudouard 41
Induction-Coils. W. Hess 312
Irreversible Radiation. M. Planck 268
Kirchhoff's Law. W. Voigt 1016
Lecher System, Improved. A. Righi 1904
Light, Monochromatic, as a Damped Vibration. A. Rovida 1336
Oscillations, *see also* Radiation.
Oscillations, Electric. M. Abraham 285
„ „ Drude 89
Oscillations, Electric, Resonance of. L. Décombe 690
Oscillations, Electric, Slow. W. König 688
Oscillations, Electrical, Period of. A. G. Webster 88
Oscillations, Electrical, in Variable Circuits. M. Petrovitch 1714
Oscillations, Hertzian, and Metal. E. Branly 90
Oscillations, Propagation of. W. B. Morton 1168
Oscillations, Round an Oscillator. K. Pearson and A. Lee 1169
Oscillators for Therapeutic Purposes. N. Tesla 287
Oscillatory Discharge. E. H. Barton 1161
Pressure Due to Radiation. W. Donle 1475
Radiating Power of Platinum Black and Lampblack. F. Kurlbaum 808
Radiation, Electrical. A. V. Abbott 1829
„ „ J. E. Taylor 1715
Radiation, Irreversible, Processes. M. Planck 1701
Thermal Radiation. K. Ångström 671
Wave Detector, Neugschwender's. E. Aschkinass 820
Wave Detector, New. A. Neugschwender 567
Wave Motion. Kelvin 1119
Wave, Plane Electromagnetic, Equations of. E. B. Rosa 1665
Waves, Deformation of. P. Vieille 1632
Waves, Elastic, Reflection and Refraction of. C. G. Knott 1633
Waves in an Elastic Solid. Kelvin 1120, 1631
Waves, Electric. E. H. Barton 284
Waves, Electric, Absorption of. E. Branly and G. le Bon 1167
Waves, Electric, Absorption of, and Electroluminescence. H. Kauffmann 1499
Waves, Electric, their Measurement, and their Absorption by Water. A. D. Cole 568
Waves, Electric, Velocity of. C. Gutton 1498
„ „ „ G. V. MacLean 1497
Waves, Electrical, Propagation of. M. I. Pupin 1381
Waves, Electromagnetic. C. Gutton 93
Waves, Electromagnetic, and Conductivity of Selenium. B. Agostini 291
Waves, Electromagnetic, Polarised. K. Waitz 290
Waves, Electromagnetic, near Wires. A. Sommerfeld 570
Waves, Explosion-, Collision of two. R. H. Jones and J. Bower 408

For the **Explanation** of this Index see p. 909.

Abstract Nos.

Radiation, Waves, Oscillations (*see also* Rays, Resonance and Discharge), *continued.*

Waves, Hertzian, Reflection of. L. le Forest 1903
Waves, Hertzian, Transparency to. G. de Bon 1500
Waves, Hertzian, Velocity of. V. Boccara and A. Gandolfi 459
Waves, Liquid, Propagation of. G. Poisson 409
Waves, Longitudinal. G. Bongiovanni 410
Waves, Wire-, Electric. W. D. Coolidge 689
Wireless Telegraphy, "Attennæ" in. A. Blondel 460

Rays, *see also* section Radiation.

Anode Rays. A. Broca 565
Becquerel Rays. O. Behrendsen 1867
„ „ J. Elster and H. Geitel 254, 1866
Canal Rays. A. Wehnelt 566
Condensation Nuclei. C. T. R. Wilson 662
Dark Light. G. Le Bon 548
Discharge in a Magnetic Field. A. Broca 815
Discharge Rays, Conductivity of Gases exposed to. J. J. Thomson 1895
Discharge Streams. J. E. Moore 1022
Discharges, Electrical. J. Trowbridge 563
Kathode and Canal Rays. O. Berg 1900
Kathode and Canal Rays, Mechanics of. P. Ewers 1899
Kathode Fall of Potential in Gases. J. W. Capstick 83
Kathode and Lenard Rays. E. Goldstein 456
Kathode Phenomena, Duration of. E. Wiedemann 685
Kathode Rays. D. F. Tollenaar 686
„ „ P. Villard 85, 86, 454
„ „ A. Wehnelt 1711
Kathode Rays, Chemical Action of. J. J. Thomson and S. Skinner ... 84
Kathode Rays, Conversion of, into Light. E. Wiedemann 36
Kathode Rays, Deflection of. W. Kaufmann 282
„ „ „ E. Merritt 455
Kathode Rays, Diffusion of. W. Kaufmann 1898
Kathode Rays in Investigating Alternating Currents. E. E. Seefehlner 1512
Kathode Rays, Reaction Pressure of. E. Riecke 283
Kathode Rays, Reflection of. H. Starke 87
„ „ „ A. A. C. Swinton 687
Kathode Rays, Velocity and Deflection of. E. Wiechert 1163
Kathode and Röntgen Rays. G. Guglielmo 818
„ „ „ W. Sutherland. Also J. J. Thomson ... 1162
Luminescence, Residual. G. Le Bon 550
Magnetised Electrodes, Vacuum Tubes with. C. E. S. Phillips 683
Phillips' Phenomenon. S. P. Thompson 1710
„ „ G. W. Walker 1902
Pitch Blende, Radio-active. P. Curie and Mme. S. Curie 35
Printing by X-Rays 1256
„ „ F. S. Kolle 1257
Radiation, Electrical. A. V. Abbott 1829
Radio-actice Baryta and Polonium. F. Giesel 1868
Radio-active Bodies. H. Becquerel 1002
Radio-active Element. P. Curie, Mme. P. Curie, and G. Bémont ... 664
„ „ M. Demarçy 664
Radio-active Substance, New. E. de Haën 1682
Radiography. O. Murani. Also Malagoli and Bonacini 433
Radiography, Stereoscopic. V. Chabaud 799
Röntgen Ions, Charge Carried by. J. J. Thomson 1679
Röntgen and Kathode Rays. J. von Geitler 37
Röntgen Radiation. J. Zeleny 798
Röntgen Radiation, Duration of. H. Morize 437
Röntgen Radiation, Mechanical Action during. F. Neesen 1486
Röntgen Ray Photography and Alloys. C. T. Heycock and F. H. Neville 1394

For the **Explanation** of this Index see p. 909.

Abstract Nos.

Rays (*see also* section Radiation), *continued.*
Röntgen Ray Screens. P. Villard 430
Röntgen Ray Shadows. E. Villari 434
Röntgen Rays. G. Guglielmo 429
Röntgen Rays, Absorption of. J. H. Gladstone and W. Hibbert..... 1003
Röntgen Rays, Absorption of, by Air. J. Trowbridge and J. E. Burbank 1487
Röntgen Rays, Chemical Action of. P. Villard 1144
Röntgen Rays, Corpuscular Theory of. B. Walter 38
Röntgen Rays, Deflection of. R. Malagoli and C. Bonacini 1353
Röntgen Rays, Diffraction of. H. Haga and C. H. Wind..... 1871
" " " M. Maier 1870
Röntgen Rays, Discharge by. E. Villari 435
Röntgen Rays, Electric Currents Induced by. A. Winkelmann 797
Röntgen Rays, Evaporation and Condensation under. P. Pettinelli 663
Röntgen Rays and High Temperatures. A. Volta 436
Röntgen Rays, Medical Application of. A. Redmond and Noë 432
Röntgen Rays, Secondary. G. Sagnac 34, 546
Röntgen Rays and Spark Discharges. H. Starke 252
Röntgen Rays, Transformations of. D. Hurmuzescu 431
" " " R. Malagoli and C. Bonacini ... 1352
" " " G. Sagnac 34, 546, 547, 1005
" " " Hurmuzescu 1004
Röntgen Rays, Visibility of. E. Dorn..... 253
Röntgenised Gases, Currents Traversing. W. Hillers 1485
Röntgenised Gases, Ionic Velocities in. J. Zeleny 251
Tubes, Crookes, Circulation in. A. A. C. Swinton 82
Tubes, Crookes, Electrolytic Actions near. H. Bordier and Salvador 1496
Tubes, Crookes, Fluorescence in. P. Villard 438
Tubes, Vacuum, Potential Gradients in. E. Wiedemann and G. C. Schmidt 280
Tubes, Crookes, Residual Phenomena in. A. Sandrucci 817
Tubes, Crookes, Therapeutic Use of. F. de Courmelles 1351
Tubes, Vacuum, Energy Consumed in. H. Ebert 684
Uranium Radiation. E. Rutherford 1001
Uranium Radiation, Source of. W. Crookes..... 549
Vacuum Phenomenon, New. L. Fomm..... 1712

Rectifiers.
Alternate Currents, Rectification of 917
Leblanc Rectifiers, Applications of. E. Sartiane and Aliamet 1583
Polyphase Currents, Transformer and Rectifier for. J. Sahulka..... 505
Rectification of Alternating Currents. P. Janet 125
Rectification of Currents. L. Kallir 1090
Rotary Converters, *see* section Transformers and Rotary Converters.
Single-Phase Rectifier, Design of. J. C. Brocksmith 1786
Transformers, *see* section Transformers and Rotary Converters.

Reflection.
Brightness of Sources of Light. P. Jenko..... 994
Irregular Reflection. C. C. Hutchins..... 993
Magneto-Optic Phenomena. J. G. Leathem..... 1139
Mercury Surfaces, Reflection at. H. Wallbott..... 1654
Metallic Reflection. E. Hagen and H. Rubens 992
Optical Properties of Minerals. H. Rosenthal..... 1848
Polarisation of Diffused Light. A. Lafay 1339
Reflection of Light. A. Lafay 991
Reflection and Refraction of Light. Lord Kelvin 783
Total Reflection. E. Ketteler 1134
" " W. Voigt 418, 1330

Refraction.
Bands by two Gratings. F. F. Martens..... 420
Chloride Solutions, Refractive Indices of. J. Conroy..... 1136

For the **Explanation** of this Index see p. 909.

Abstract Nos.

Refraction, *continued.*
Electrochemical Theory. R. Mewes 1213
Focal Plane of a Photographic Objective, Distribution of Light on. M. von Rohr 244
Garnet, Optical Characteristics of. C. Klein 1135
Hydrophane, Properties of. J. Stscheglayew 22
Magneto-Optic Phenomena. J. G. Leathem 1139
Maxwell's Theory, Extension of. E. Edser 784
Prismatic Images. R. Straubel 243
Refraction and Reflection of Light. Lord Kelvin 783
Water, Pure, Refractive Index of. C. Bender 1471
Resonance (Electric, *see also* Radiation).
Hertzian Field in Air and in Oil. A. Turpain 91
Light, Monochromatic, as a Damped Vibration. A. Rovida 1336
Oscillations, Electric, Resonance of. L. Décombe 690
Resonator with Gap. A. Turpain 1382
Resonator, Hertz, Modification of. A. Turpain 691
Resonators. Oudin 92
Solution and Solubility.
Carvoximes, Solubility of. H. Goldschmidt and H. C. Cooper 138
Colloid Solutions, Coagulation of. J. Stark 1741
Cryoscopic Solvents. F. Garelli 479
Dilution of Electrolytes, Law of. T. P. Muller 1230
Dilution, Thermal Effects of. J. H. Pollok 1396
Electrolyte, Binary, Influence of, on Solubility of a Ternary Electrolyte. A. A. Noyes and E. S. Chapin 1231
Electrolyte, Binary, Solubility of, in a Solution of another having Different Ions. A. A. Noyes 851
Electrolytes, Solubility and Heat of Formation of. G. Bodländer ... 726
Gases, Solution of, in Liquids. C. Bohr 1738
Heat of Solution. J. J. van Laar 1544
Heat of Solution, Ionisation and Solubility of Electrolytes. A. A. Noyes 730
Heat of Solution and Solubility of Electrolytes. J. J. van Laar 729
Ionisation, *see* section Dissociation.
Iron and Steel, Solution Theory of. H. J. von Jornstorff 848, 1742
Isomorphous Bodies, Mixtures of. G. Bruni 485
Isothermal Pressure-surface for a Mixture of Two Single and One Resulting Double Salt. F. G. Donnan 594
Mutual Solubility: Vapour Pressure and Critical Points of Mixtures. J. P. Kuenen and W. G. Robson 1220
Racemic Compounds and Mixtures. H. W. B. Roozeboom 1210
Salts of Weak Acids, Solubility of, in Stronger Acids. A. A. Noyes and D. Schwartz 724
Saturation-Point of Solutions, Electrical Determination of. J. H. van't Hoff 1937
Solid Solutions. H. P. Cady 1205
Solubility, Ionisation, and Heat of Solution. H. Goldschmidt 1056
Volumes of Aqueous Solutions. E. B. H. Wade 1211
Water, Dissociation of. R. A. Lehfeldt 725
Sound.
Air Waves produced by a Pendulum. E. Ketteler 1698
Air Waves due to Projectiles. Obermayer 9
Beats of Strings. C. Maltezos 1884
Chladni Plates, Circular. J. Zenneck 264
Difference Tones. A. Appunn 446
Discontinuities, Velocity of Propagation of. P. Vieille 266
Efflux of Gases. R. Emden 1836
Electrical Transmission of Sound. Dussaud 560
γ, Variation of. A. Leduc 260
High Frequency, Notes of. F. Melde 810

For the **Explanation** of this Index see p. 909.

Sound, *continued.* Abstract Nos.

Manometric Flames, Photography of. E. L. Nichols and E. Merritt 65
Measurement of Sound. B. F. Sharpe 1696
Phonograph, Loudness of. Dussaud 556
Pipes, Appunn, Pitches of. F. A. Schulze 1368
Pipes, Organ, Conical and Irregular. Neyreneuf 1370
Pipes, Vibrations of. A. Appunn 445
Pitches, Determination of. C. Stumpf 1369
Pitches, High. F. A. Schulze 1885
Plates, Vibrations of. J. Zenneck 444
Propagation of Sound and Cooling of Air. Rayleigh 1371
Radiophone 1372
Radiophony. Dussaud 557
„ A. Sella 558
Resonators, Acoustic. A. Pochettino 1699
Strings, Caoutchouc, Vibrations of. V. von Lang 1697
Tuning Plates. F. Melde 265
Velocity of Sound. A. Leduc 811
Velocity of Sound in Air. J. Violle 555
Vowel Sounds. Marage 63
„ „ Monoyer 64
Wind Instruments, Theory of. F. Larroque 1883

Specific Heat and Latent Heat.

Dulong and Petit's Law. F. Richarz 1363
Fusion, Heat of. G. Tammann 1150
γ, Variation of. A. Leduc 260
Gases, Ratio of Specific Heats of. L. Boltzmann 666
Latent Heat of Evaporation of Zinc and Cadmium. W. Sutherland 45
Low Temperature Specific Heats. U. Behn 258
Mechanical Equivalent of Heat and Specific Heats of Gases. A. Leduc 261
Regnault's Calorie and the Specific Volumes of Steam. G. P. Starkweather 1008
Specific Heat. L. Pfaundler 665
Specific Heat of Gases. O. Lummer and E. Pringsheim 44
„ „ „ S. Lussana 43
Specific Heat of Liquids. E. Gumlich and H. F. Wiebe 259
„ „ „ D. Negreano 1149
Specific Heat of Water. H. L. Callendar and H. T. Barnes 1879
Specific Heats of the Elements. W. A. Tilden 42
Variation of Specific Heat. L. Sohncke 802

Spectra.

Absorption Spectra of Gaseous Mixtures. P. Baccei 1483
Argon Spectrum. Red End. C. Runge 1861
Benzene, Absorption Spectrum of. W. N. Hartley and J. J. Dobbie 1675
Black Body, Energy in the Spectrum of a. O. Lummer and E. Pringsheim 1482
Black Body, Spectrum of. F. Paschen 1348
Broadening of D-lines. H. Wanner 1347
Determination of Spectra. M. Hamy 1673
Gases, Absorption Spectra of. P. Baccei 1346
Glow-Discharge Spectra. A. Kalähne 39
Hydrogen, Spectra of. T. W. Richards 1345
Interferential Spectroscopy. Jobin 250
Kirchhoff's Solar Spectrum. J. Hartmann 796
Luminosity, Source of. H. Crew and O. H. Basquin 543
Luminosity of Spectra of Gases. E. S. Ferry 40
Magnetism and Gas Spectra. E. van Aubel 428
Oscillating Discharges, Spectra of. G. A. Hemsalech 1860
Photography, Spectroscopic. J. H. White 1676
Prismatic Spectra, Reduction of. E. Edser and C. P. Butler 249

For the **Explanation** of this Index see p. 909.

Abstract Nos.

Spectra, *continued.*
Sellmeier's Theory. Kelvin 1672
Solar Spectrum, Hydrogen Lines in. L. E. Jewell 1862
Solar Spectrum, Telluric Lines in: A. de la Baume-Pluvinel 989
Spectra. A. Pérot and C. Fabry 1143
Spectrum Analysis. N. Lockyer 1484
Stars, New, Spectra of. J. Wilsing 1649
Vacua, High, by Liquid Hydrogen, with their Spectroscopic Examination. J. Dewar 592
Zeeman Effect, *see* separate section.

Static Electricity, *see also* section Discharge.
Atmospheric Electricity. Chauveau 70
Atmospheric Electricity, Theories of. Chauveau 1704
Atmospheric Potential. E. Oddone 1705
" " H. Pellat 1706
Contact Electricity. A. Heydweiller 273
Contact Electrification. A. Coehn 1020
Contact and E.M.F. Q. Majorana 1385
Density on an Ellipsoidal Conductor. E. Armanini 69
Dirichlet's Principle. W. Stekloff 677
Electricity and Fog. A. Garbasso 449
Electrification of Air. Kelvin, M. Maclean, and A. Galt 1494
Electrolytic Gas, Electric Charge of. W. Kösters 1887
Electrostatic Theorems. P. Saurel 1373
Evaporation, Loss of Electric Charge by. H. Pellat 562, 1375, 1888
Flame-electrodes and Dropping-electrodes. E. R. v. Schweidler ... 303
Leakage of Electricity from Charged Bodies. J. C. Beattie 1376
Lightning and Lightning Arresters. H. E. Raymond 1956
Lightning Discharges from Lines. C. P. Steinmetz 73
Lightning, Ribbon and Dark 1886
Lines of Force. V. Boccara 813
Polarisation, Instantaneous. H. Pellat 1158
Polarisation, Persistent. H. Pellat 1159
Volume-Changes of Gases under High E.M.F. H. Mache 1160
Wimshurst Machines. S. Leduc 447

Surface Tension.
Aqueous Solutions, Surface Tension of. C. Forch 1834
Capillary Angles. A. Rota 400
Capillary Constants. A. Gradenwitz 644
Capillary, Electro-, Phenomena. S. W. J. Smith 821
Capillary, Thermodynamic Theory of, Van der Waals'. G. Bakker ... 1320
Films, Liquid, Spreading of. J. Stark 10
Mercury, Surface Tension of. G. Meyer 229
" " " J. Stöckle 228
Surface Tension. H. Wallbott 1622
Surface Tension by Ripples. L. Grunmach 1315
Surface Tensions. A. Pockels 645
Water, Surface Tension of. P. Volkmann 227

Telegraphy.
Bell's Selenium Transmitter 1310
Benches for Telegraph Apparatus. E. Lönnqvist 1826
Cables, *see* Cables, Conductors and Wiring.
Charging Accumulators from Primary Batteries, Economy in. L. Brunelli 636
Coherers, *see* Miscellaneous (Electricity and Magnetism).
Distant Mechanism, Control of 898
Faults in Submarine Cables, Detecting. E. Jona 1173
" " " " W. J. Murphy 1174
Hertz Telegraphy. M. Tietz 220
Hertzian Telegraphy. E. Ducretet 534
Induction Telegraphy. J. Voisenat 1450

For the **Explanation** of this Index see p. 909.

Abstract Nos.

Telegraphy, *continued.*
Interrupters, *see* Miscellaneous (Electricity and Magnetism).
KR Law. W. Moon 1374
Lodge and Muirhead's Telegraph. J. Blondin 1108
Mercadier's Multiplex Telegraphy 1995
Morse Sounders 1828
Pacific Cable. C. Bright 966
Photographic Receiver for Cable Signals. J. Pinter 1825
Printing Telegraph, Higgins' 967
Radiophony. Dussaud 557
„ A. Sella 558
Relay Transmitters. E. Lönnqvist 1107
Rowland's Printing-Telegraph 1309
Selector System of Circuits. E. Bernard 1997
Simultaneous Telegraphy and Telephony. C. Selden 1831
Siphon-recorder Signals. J. Rymer-Jones 1106
Space Telegraphy. O. Lodge 960
Space Telegraphy (Inductive). S. Evershed 961
Space Telegraphy, Magnetic. W. H. Preece 962
Telautograph with Rotary-field Drive. F. J. Patten 1824
Telediagraph 1607
Translator for the Printing Telegraph 1827
Van Rysselberghe's Anti-Inductive Combination of Telegraphs and Telephones. M. Colard 1453
Van Rysselberghe's System, Intensity of Received Current in. M. Colard 1454
Wireless Telegraphy. W. Bissing 1109
„ „ A. Broca 965
„ „ J. J. Green 1996
„ „ J. Kitsee 1830
„ „ G. Marconi 1452
„ „ Della Riccia 963
„ „ Schluckebier 222
„ „ A. Turpain 964
Wireless Telegraphy, "Attennæ" in. A. Blondel. Also A. Broca ... 460
Wireless Telegraphy in the French Navy. Tissot 1606
Wireless Telegraphy, Syntonised Vibrators for 221
Wireless Telegraphy, Tall Wires in. R. Kennedy 1451

Telephony.
Automatic Telephone Board 394
Cables, Telephone, Dielectric for 638
Call-Check, Weber's 1312
Call Dials, Telephone. L. Montillot 395
Central Equipment, Telephone. H. P. Clausen 391
Combined Telephone and Electric Light Stations. H. P. Clausen ... 396
Cross Talk, Causes of. K. B. Miller 1110
Eight Subscribers on One Pair of Wires. H. Webb 976
Energy, Centralised Sources of 972
Exchange Improvements, Recent. K. B. Miller 1457
Exchange System, Telephone. G. Ritter 1616
Exchange, Telephone, in Paris. G. de la Touanne 1456
Exchanges, Telephone. H. P. Clausen 1458
„ „ K. B. Miller 1311
„ „ B. von Wehrenalp 1998
"Express" System. K. B. Miller 971
Indicator, Telephone. P. Rabbridge 392
Induction in Telephone Circuits. Colard 1609
London-Birmingham Telephone Cables 973
Long-Distance Telephony. J. H. Winfield 1614
Motograph as a Telephone Relay. W. J. Hammer 1613
Motograph as a Telephone Repeater 1612

For the **Explanation** of this Index see p. 909.

Abstract Nos.

Telephony, *continued.*
New York Telephones. M. Loewenthal 1314
Paris, New Telephone System in. M. O'Gorman 223
Party Lines, Telephone. H. S. Webb 1459
Private Central Telephone Stations. Mandroux 1999
Railway Telephone. L. Montillot 974
Register, Automatic Call. H. T. Richards 1615
Scribner's Connection Counter 1313
Simultaneous Telegraphy and Telephony. C. Selden 1831
Single Exchange Line for Five Subscribers. J. H. West 1832
Switchboard, "Express" 970
Switchboard, Multiple. Dubreuil 968
Switchboard, Telephone 536
Switchboard for Toll Lines. H. P. Clausen 969
Telephone Distances exceeding the KR Law. A. E. Dobbs 535
Telephone Engineering. T. Spencer 1608
Telephone Repeater. K. B. Miller 637
Telephone Systems. C. Raphael 224
Telephone Work. A. E. Dobbs 225
Transmitter, Germain's Loud-Speaking. G. Dumont 1833
Transmitter in Vacuo 975
Transmitter Working with 20 Volts. G. Dumont 2000
Troubles, Telephone. H. P. Clausen 1611
Van Rysselberghe's Anti-Inductive Combination of Telegraphs and Telephones. M. Colard 1453
Van Rysselberghe's System, Intensity of Received Current in. M. Colard 1454
Weber's Call-Check 1312

Temperature.
Absolute Temperature. K. Schreber 1015
" " O. Wiedeburg 50
Conductor, Temperatures in a Linear Bimetallic. P. Straneo 443
Conductor of Two Metals, Temperature of. P. Straneo 51
Flame Temperatures. F. Berkenbusch 670
Hydrogen, Boiling-Point of. J. Dewar 1489
Measurement of Temperature 48
Measurement of Temperature and Pressure. K. Scheel 1874
Normal Temperature and Thermometric Fixed Point. W. Meyerhoffer and A. P. Saunders 1009
Transition-temperatures as Thermometric Fixed Points. T. W. Richards and J. B. Churchill 1010

Temperatures, High and Low.
Air, Liquid. F. Dommer 1360
Hydrogen, Boiling-point of. J. Dewar 668, 1489
Light at Low Temperatures. A. and L. Lumière 1129
Specific Heats. U. Behn 258
Thermo-Electric Pyrometry. A. Stansfield 31

Terrestrial Magnetism and Electricity.
Diurnal Variations of Magnetic Disturbances. G. Lüdeling 1194
Earth-currents in Germany 1175
H, Determination of. H. Wild 1037
Madagascar, Magnetic and Geodetic Observations in. P. Colin 474
Magnetic Charts. E. Mathias 475
Magnetic Elements on January 1, 1899. T. Moureaux 476
Magnetic Elements at Potsdam 72
Magnetic Elements of Potsdam. M. Eschenhagen 1934
Magnetic Inclination Deduced by Magnetisation of Clay. G. Folgheraiter 1039
Magnetic Inclination in Ancient Times. G. Folgheraiter 1734
Magnetic Variation, Annual. G. Schwalbe 1038
Terrestrial Magnetism, Variations of. G. Lüdeling 71

For the **Explanation** of this Index see p. 909.

Abstract Nos.

Theories.*
Conductors, Networks of, of Finite Transverse Dimensions. J. B. Pomey 1703
Directive Action of one Crystal on another. J. H. Poynting and P. L. Gray 777
Electrostatic Theorems. P. Saurel 1373
Electrostriction and Electrodynamic Equation of a Moving Material Medium. J. Larmor 66
Equations of Condition. O. Wiedeburg 1838
Irreversible Processes. O. Wiedeburg 62
Liquids with Unassociated Molecules (Part II.). G. Bakker 59
Motion of a Charged Ion in a Magnetic Field. J. J. Thomson 1896
Rectilinear Diameters and the Laws of Corresponding States. E. Mathias 1878
Results, Interpretation of. E. Vallier 649
System in Motion, Variations of. Natanson 1324
Theories of Lorenz and of Larmor. A. Liénard 267

Thermodynamics (*see also* section Gases).
Biological Thermodynamics. A. Chauveau 1691
Carnot's Engine, Model of. J. C. Shedd 1367
Efficiency, Thermal, of Steam Engines 178
Heat-stuff, Energy and Entropy. O. Wiedeburg 1692
Irreversible Processes. O. Wiedeburg 62
Isothermal Pressure-surface for a Mixture of Two Single and One Resulting Double Salt. F. G. Donnan 594
Joule-Thomson Thermal Effect. E. F. J. Love 1355
Kinetic Theory of Liquids. G. Jäger 1364, 1694
" " " W. Voigt 1365, 1882
Liquid Mixtures. R. A. Lehfeldt 61
Maxwell's Theorem. P. Saurel 1492
Mechanical Equivalent of Heat and Specific Heats of Gases. A. Leduc 261
Permanent Changes and Thermodynamics. P. Duhem 1354
Pressure, Volume, and Temperature in Fluids. E. H. Amagat 1877
Rectilinear Diameters and the Laws of Corresponding States. E. Mathias 1878
Thermodynamic Equivalence in a Bimetallic Conductor. P. Straneo 773
Thermodynamics. K. Wesendonck 675

Thermo-Electricity.
Bismuth and its Alloys, Thermoelectric Properties of, and Magnetism. G. Spadavecchia 1931
Bismuth, Crystallised. L. Perrot 104
Crystalline Polarisation, Kinetic Theory of. J. Beckenkamp 657
Electro-Thermal Relations. E. Riecke 299, 1024
" " W. Voigt 822
Pyroelectricity. W. Voigt 300
Strain and Thermoelectric Properties. M. Maclean 1177
Thermodynamic Equivalence in a Bimetallic Conductor. P. Straneo 773
Thermodynamics of Thermo-couples. C. Liebenow 1516
Thermoelectric Battery. C. J. Reed 309
Thermoelectric and Galvanic Action. C. J. Reed 701
Thermo-electromotive Forces. C. Liebenow 1515
Thermopile and Bolometer, Conditions of Sensitiveness. H. C. Pocklington 1876
Thomson Effect in Copper. R. O. King 575

Traction, Electric (Accumulator).
Accumulators for Motor Cars. J. Reyval 600, 1246
" " " P. Northey. Also Oppermann 1294
Accumulators for Traction. L. Schröder 1286

* This section only includes such papers, chiefly theoretical, as are not readily indexed under other headings.

For the **Explanation** of this Index see p. 909.

Abstract Nos.

Traction, Electric (Accumulator), *continued.*
Accumulators, Fulmen and Motor Cabs in Paris. E. Hospitalier ... 602
Bremerhaven, Accumulator Traction in. Sieg ... 1593
Cab Charging Station ... 381
Cabs, Paris Electric ... 1600
Cabs, Motor in Paris and Fulmen Accumulators. E. Hospitalier ... 602
Design, Motor Car. T. H. Parker ... 1296
Electric Traction. C. P. Feldmann ... 1438
Electric Traction. A. D. Greatorex ... 1982
Hanover, Mixed System at ... 930
Joel Motor Car ... 1295
Locomotive, Electric, of the Paris-Lyons Mediterranee Company ... 1595
Motor Car, Combined Electric and Petrol. E. Hospitalier ... 1994
Motor Car Trials. E. Hospitalier ... 382
Motor Car, "Torpedo" ... 1599
Motor Cars ... 385
Motor Cars. E. Hospitalier ... 383, 1816
" " J. Reyval ... 384
Motor Cars, American. T. B. Booth and S. S. Sherman ... 1817
Motor Cars, Electric. E. Egger ... 1598
" " " F. Wilking ... 1597
Motor Cars in New York. G. H. Condict ... 1103
Motor Cars, Riker ... 1815
Traction, Accumulator. M. van Loenen-Martinet ... 626
Vehicles, Electric, and their Relation to Central Stations. H. M. Maxim 902

Traction, Electric (Trolley, Conduit or Contact, &c.).
Accumulator Sub-stations for Tramways ... 929
Allen and Peard's Mechanical Contact System ... 630
American Electric Railways. W. J. Clark ... 1810
"Anderson" Closed-Circuit ... 369
Argentine Tramways ... 1098
Ashton Works and Tramways ... 1801
Axles, Breakage of. J. F. Thompson ... 1299
Bastille-Charenton Tramway ... 770
Blackburn Tramways ... 1096
Blackpool Trolley Line ... 1799
Block System, Automatic. C. F. Bancroft ... 1444
Bommern-Witten Tramway. M. Schiemann ... 1981
Boston, New Union Station ... 926
Boston Railway, Power House. H. W. Weller ... 1284
Boston Subway ... 209
Bristol Tramways ... 1288
Building an Electric Railway. L. W. Serrell ... 1810
Canal Haulage, Electric. A. H. Allen ... 616
Canals, Electric Traction on. Van der Wallen ... 617
Car, Tram-, Development of the. J. A. Brill ... 1810
Cars for Special Purposes ... 528
Chicago Elevated Railroad ... 518
Chicago Elevated Railway. J. R. Cravath ... 521
Chicago and Milwaukee Railway ... 769
City and South London Railway. P. V. McMahon ... 1810
Cleveland Railway Power Station ... 1285
Comparison of Electric and Steam Traction. B. H. Thwaite ... 1594
Conduit Railways: Latest Developments in. F. S. Pearson ... 1810
Conduit System, Jenny ... 215
" " Smith's Overhead ... 1993
Conduit *v.* Trolley System. J. Young ... 627
Contact System, Mechanical, Allen and Peard's ... 630
Cork Electric Tramways. B. Griffin ... 206
Corrosion of Pipes by Return Currents of Electric Tramways. J. A. Fleming ... 218

For the **Explanation** of this Index see p. 909.

Abstract Nos.

Traction, Electric (Trolley, Conduit or Contact, &c.), *continued.*

Cost of Electric Tramways 214
Cost of Electrical Energy for Tramways. R. W. Conant 368
Cost of Rapid Transit. J. R. Cravath 1440
Costs of Cable, Electric and Horse Traction 524
Costs, Traction. W. A. Harding 525
Design, Electric Traction Statistics as Data for. A. Hecker 1983
Detroit Railways 1097
Dudley and Stourbridge Tramways 1591
Düsseldorf-Krefeld Electric Railway. G. Braun 1808
Earth Returns, and Electrolysis. A. B. Herrick 219
Electric Traction. A. H. Armstrong 367
" " C. P. Feldmann 1438
" " A. D. Greatorex 1982
" " P. Lauriol 213
" " H. F. Parshall 937
Electric Tramways. P. Cardew and A. P. Trotter 212
" " G. Conaty 1439
Electric Tramways in South Africa 519
Electrolysis of Cast-Iron Pipes. H. P. Brown 614
Electrolysis in Ground Returns. A. B. Herrick 219, 941
Electrolysis from Railway Currents. A. V. Abbott 1810
Electrolysis by Stray Currents. A. A. Knudson 1074
Electrolysis and Ground Returns 1984
" " " M. Kallmann 1301
Electrolysis of Pipes. J. A. Fleming 218
Equipments, Street Car. A. B. Herrick 1292
Erie Railroad, Electric Traction on 207
Expenses of Railways 1287
Experimental Railway Line 934
Feeders, Return, for Electric Railways. B. Böhm-Raffay 1811
Glasgow Tramways 364
Guest Conduit System 1102
Hanover, Mixed System at 930
Havre, Electric Traction at 210
Hull Tramways 1802
Jungfrau Railway 933
Kingston (Jamaica) Electric Tramways. H. E. Raymond 1805
Lausanne Tramways. C. du Riche Preller 926
Lewiston, U.S.A., Line at 1099
Liverpool Tramways 517, 931
Locomotive, Electric. G. R. Mair 1810
Lorain & Cleveland Interurban Railway 1807
Lyons, Traction at 932
McGurty High-speed Mail System 768
Maxham Third Rail. L. M. Maxham 371
Mechanical Applications of Electricity. G. Richard 1250
Metropolitan Railways. P. Dawson 935
Milwaukee Electric Railways 1803
Mishaps, Trolley Car. S. Woodfield 1293
Moreau Closed Circuit System 216
Multiple Unit System for Electric Railways. F. J. Sprague 1810
Municipal Ownership of Tramways. B. Taylor 1810
Murphy Third Rail 523
New Haven and Hartford Railways. H. N. Heft 366
New York, Conduit Construction 944
Overhead Construction. J. G. White 1810
Overhead Line Construction. A. B. Herrick 1987
Overhead Line Material for Electric Railways. Benz 1986
Permanent Way. W. H. Rosencrans 1290
Philadelphia Traction Company 520

For the **Explanation** of this Index see p. 909.

Abstract Nos.

Traction, Electric (Trolley, Conduit or Contact, &c.), *continued.*

Pittsburg Power Station 1095
Platform Railway, Moving. E. Miot 1601
Polyphase Currents for Railways. D. C. Jackson 1810
Potteries Electric Tramways 1980
Power Distribution for Traction. E. Wilson 938
Power for Electric Traction. J. G. Scott 1809
Power Station of Elevated Railway, Chicago 1804
Problems, Traction. J. Neidt 1101
Rail-Bonding 527, 1302
„ R. D. Appleton 1988
„ R. P. Brown and G. E. Chapin 526
„ C. Thonet 1441
Rail Bonds 375
Rails and Rail Joints. M. K. Bowen 1810
Railways, Light Electric. L. Bell 1810
Rapid Transit. J. Lundie 1289
Rapid Transit, Cost of. J. R. Cravath 1440
Repair Shops at Cincinnati 1814
Rolling Stock, Selection of. C. F. Uebelacker 1810
Siemens and Halske Conduit. G. Braun 370
Signalling, Railroad. C. C. Anthony 1253
Springfield and Holyoke Electric Railways, Mass. 208
Stansstad-Engelberg Railway 1100
Statistics as Data for Design, Electric Traction. A. Hecker 1983
Stendebach and Linker's Conduit and Surface-Contact 943
Storage Batteries and Electric Railways. H. Lloyd 1810
Storage in Traction Stations. R. McA. Lloyd 1436
Stray Currents on Electric Railroads 1301, 1984
Suburban Railways 939
Surface Contact 372
Surface Contact, Johnson-Lundell. E. H. Johnson 522
Surface Contact System, Diatto. J. Blondin 1992
Surface Contact, Thompson-Walker. M. Walker 942
Surface Contact, Thompson-Walker System. S. P. Thompson and M. Walker 217
Surface-Contact System of the Union Elektricitäts Gesellschaft. M. Kubierschky 1442
Survey, Electrical, in New York. A. A. Knudson 899
Swing-Bridge Crossing. E. Dieudonné 365
Switzerland, Electrical Engineering in 1800
Test of Power Station 508
Tests of Traction Plant. G. W. Munro 507
Third-Rail System, Murphy. E. V. Baillard 1443
Thomson's System of Train Control 945
Three-Phase Traction. E. K. Scott 936
Three-Phase Tramway at Evian-les-Bains 211
Three-Phase Transmission for Philadelphia Tramways 1806
Track Construction. D. F. Carver 946
Track Construction in Cincinnati 1812
Traction, Electric. C. A. Carus-Wilson 625
Traction History, Early. T. Reid 1810
Train Resistance. J. B. Blood 1303
„ „ H. Graftio 1596
Tramcar Design. H. Mozley 1291
Tramway Track Construction. C. P. Wilson 373
Tramways, Electric, in Great Britain. R. W. Blackwell 1810
Truck Cars, Single and Double. J. J. Beggs 379, 629
„ „ „ „ R. McCulloch 379
Truck, Moore's 1298
Truck, Passenger Locomotive 628

For the **Explanation** of this Index see p. 909.

Abstract Nos.

Traction, Electric (Trolley, Conduit or Contact, &c.), *continued.*
Truck, Peckham 380
Trucks, Car 378
Washington, Traction at 928
Washington Tramways 1592
Welding, Electric Rail 1989
Welding, Electric, of Rails. H. F. A. Kleinschmidt 1813
Wheels, Car, Thermal Tests for 1991
Works, Combined Lighting and Traction. J. H. Rider 1798

Traction, Mechanical.
Comparison of Electric and Steam Traction. B. H. Thwaite 1594
Cost of Rapid Transit. J. R. Cravath 1440
Costs of Cable, Electric and Horse Traction 524
Costs, Traction. W. A. Harding 525
Expenses of Railways 1287
Mechanical Traction. E. A. Ziffer 940
Resistance, Train. J. B. Blood 1303
„ „ H. Graftio 1596

Transformers and Rotary Converters.
Alternating Current Transformer. W. F. White 189
Balancers, Rotary. C. B. Davey 1269
Carborundum Company, Transformer Equipment. J. S. Peck 916
Cores, Transformer. E. K. Scott 1782
Current-rushes in Transformers. A. Hay 193
Economy, Transformer. W. E. Goldsborough 190
High-speed Rotary Converters. E. K. Scott 1787
Improvements in Transformers. C. F. Guilbert 191
Losses, Transformer Core. W. E. Goldsborough 1783
„ „ G. W. Hubley 1785
Losses, Transformer, Effect of Wave-Form on. L. Duncan, F. B. Keidel, W. L. Hodges, and E. Frank 1580
Phase Transformer, Design of. A. F. McKissick 192
Polyphase Currents, Transformer and Rectifier for. J. Sahulka 505
Problems, Transformer. C. Heinke 1581
Rectifiers, *see* section Rectifiers.
Regulation, Transformer. F. Bedell 357
Rotary Converters. Aliamet 1280
„ „ P. Janet 356
„ „ E. de Marchena 506
„ „ C. Pio 1582
„ „ R. B. Ritter 1435
„ „ C. P. Steinmetz 758
„ „ S. P. Thompson 757
Rotary Converters, High-Speed. E. K. Scott 1787
Rotary Converters, Theory of. G. Kapp 1091
Rotary Transformers and Storage at Hartford, Long-Distance Transmission with. W. L. Robb 1794
Single-Phase to Polyphase 1279
Tests, Transformer. W. E. Goldsborough 1784
Theory of Rotary Converters. G. Kapp 1091
Three-Phase, Transformation of, to Two-Phase Currents. P. G. Watmough 1788
Transformer Diagram. F. G. Baum 1191
Transformer for 150,000 volts. E. B. Paine and H. E. Gough 188
Transformer Plates, Thickness of. F. Bedell, R. M. Klein, and T. P. Thompson 622
Transformers 913
Transmission, Long-Distance, Rotary Transformers and Storage with, at Hartford. W. L. Robb 1794
Wave-Form, Effect of, on Transformer Losses. L. Duncan, F. B. Keidel, W. L. Hodges, and E. Frank 1580

For the **Explanation** of this Index see p. 909

Abstract Nos.

Vapour Pressure.
Coexistent Phases, Pressure of. M. Cantor 719
Dalton's Law. W. N. Shaw 257
Heptane, Normal, Constants of. S. Young 1687
Hydrated Salts, Vapour Pressures of. W. Müller-Erzbach 142
Hydrates, Vapour Pressure of. G. Tammann 720
Isopentane, Thermal Properties of. S. Young 1689
Pentane, Normal, Thermal Properties of. J. Rose-Innes and S. Young 1688
Saturated Vapours. E. H. Amagat 674
Solutions, Vapour Pressure of. C. Dieterici 843
Thermal Properties of Gases and Liquids. S. Young 262
Vapour-pressure of Solutions. R. A. Lehfeldt 1746
Watef Vapour below Zero. M. Thiesen 806

Vats and Cells, Electrolytic.
Efficiency of Electrolytic Vats. C. F. Burgess 874
Electrolytic Vats. H. Becker 873
Indigo-Vats. A. Binz 153

Vision.
Colour-Blindness and the Flicker Photometer. O. N. Rood 27
Colour, Recent Views on. A. H. Abbott 788
Colour Vision. F. P. Whitman 239
Colour-Weakness and Colour-Blindness. E. W. Scripture 1663
Multiple Images in the Eye. S. Bidwell 790
Röntgen Rays, Visibility of. E. Dorn 253

Zeeman Effect and Radiation in a Magnetic Field.
Absorption in a Magnetic Field. A. Righi 421
Broadening of Spectrum Lines. W. Voigt 1671
Charged Ions in a Magnetic Field. H. A. Lorentz 1668
Kerr Phenomenon. H. Abraham and J. Lemoine 1859
Light in a Magnetic Field. D. Macaluso and O. M. Corbino 425
Magnetic Rotatory Power and Anomalous Dispersion. H. Becquerel 426
Magnetism and Molecular Rotation. Kelvin 1928
Magneto-Optic Phenomena. P. Drude 1481
" " E. Ketteler 1340
" " J. G. Leathem 1139
" " T. Preston 1479
Magneto-Optic Theory. W. Voigt 1140
Metallic Vapours in a Magnetic Field. D. Macaluso and O. M. Corbino. Also H. Becquerel 427
Optical Properties in an Electric Field. W. Voigt 1857
Radiation in a Magnetic Field. D. Macaluso and O. M. Corbino ... 792
" " " T. Preston 1000
Refraction, Magnetic Double. A. Cotton 545
Sodium Vapour, Anomalous Dispersion of. H. Becquerel 999
Sodium Vapour in Magnetic Field. W. Voigt 1343
Zeeman Components, Intensities of. W. Voigt 1858
Zeeman Effect. H. Becquerel and H. Deslandres 32, 33
" " O. M. Corbino 793
" " A. Righi 423, 1341
Zeeman Effect, Correlation of. O. M. Corbino 1477
Zeeman Effect, Theory of. D. A. Goldhammer 659
" " " W. Voigt 1478
Zeeman Effect, Inverse. A. Righi 424
Zeeman Effect and Theory of Lorentz. H. Poincaré 1669
Zeeman's and Faraday's Phenomena. W. Voigt 1342

For the **Explanation** of this Index see p. 909.